AN INFORMAL HISTORY OF ASTRONOMY AT THE UNIVERSITY OF MISSOURI - COLUMBIA

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# An Informal History of Astronomy at the University of Missouri - Columbia

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INTRODUCTION

This is an attempt to outline the astronomical effort at the University of Missouri from the beginnings of the institution to the present time. While in the years of the last century astronomy was represented in the curriculum of the University of Missouri at a level appropriate to the influence of this oldest science during that era, the height of astronomical endeavor at this institution probably occurred in the first decade of the present century during the tenure of Frederick Seares who transformed Laws Observatory into a truly functioning observatory of merit equal to the best of other observatories of its small size. But after a decade Seares left for a larger institution at which the facilities and the research opportunities were far superior. In subsequent years as the University continued to grow and to change into today's large modern system, the Astronomy Department remained small and ultimately was abandoned in the early 1950's. It still is recognized that astronomy does have a role to play in both research and education at this institution; thus astronomy courses have continued to be maintained on campus within the Physics Department.

This record has been compiled from a number of sources, beginning with the histories of the University by Viles (1939) and by Stephens (1962). Because of the overlap with Physics especially in the early years (of the five professorships established in the original University organization in 1843, one was the chair of Mathematics, Natural Philosophy (Physics), and Astronomy) and the inclusion of Astronomy within the Physics program in the last three decades, the informal history of the Physics Department by Gingrich has been most helpful, particularly (as Gingrich also points out) printed University records often are not all that clear as to the duties of the listed individuals. Also it is true that the early catalogues sometimes had more role to play in public relations than in being accurate records of the academic curriculum. Never-
theless these records have been studied and used in this document. Particularly useful were the Laws Observatory Papers, 1889 - 1954, which are held in the Joint Collection of the Western Historical Manuscript Collection of Ellis Library and the State Historical Society of Missouri. These files fortunately were salvaged from the old observatory by Professor Terry W. Edwards in 1969 shortly before its demolition to make way for the parking lot of the University hospital. They are rather incomplete, but adequate to shed significant light on the work and personalities of the University astronomers for over six decades. Wherever possible other documentation has been used to augment these records on the astronomical activities at the University, and to attempt to go beyond giving merely a dry tabulation of the persons and their work at this institution.

In doing so, I have not attempted to maintain a formally correct system of footnotes and exact bibliographical citations, a matter which will annoy professional historians but which, I felt, would destroy the informality of this document. In a record such as this which relies heavily on written documentation, one can err in placing too much emphasis on research activities for which there often is a published record and thus one can slight the equally important, but less well documented, record of teaching at the University. At the University of Missouri where the emphasis during nearly the whole of its first century of existence was placed on teaching and not on research and publications, this is particularly the case. One indication of the quality of student education is that in spite of the smallness of astronomical endeavors over the years, the University of Missouri has produced a few graduates who have gone on to make their marks in astronomy. The most successful and famous of these is without question Harlow Shapley who played a significant role in the resolution in the 1920's of the problems affecting our understanding of the size
and structure of the Milky Way Galaxy and in the definition of the scale of the Universe as a whole. As later Director of Harvard College Observatory, he not only maintained its preeminent stance in American and world astronomy for many years, but also introduced a graduate program which produced a corps of professional astronomers many of whom are still influential in the field today. That Shapley chose astronomy as a career is directly attributable to the influence of Frederick Seares and others under whom Shapley studied while at the University of Missouri. Shapley's career is detailed in an appendix.

Another outgrowth of this study was the surprising discovery that the legendary and infamous Thomas Jefferson Jackson See was once a student on this campus, graduating with honors in 1889. It is a fact of history and human interest that those who succeed in science will more often be remembered and their lives and efforts memorialized in reputable biographies. T.J.J. See does not fall into this category, as he was to go on to become one of the most colorful, eccentric, and disliked of astronomers ever produced in this country. See, an apparently brilliant individual, began a promising career that soon was to be destroyed by controversies generated by his inability to distinguish his own work from that of others and by an overconfidence in his own abilities which led him to make fundamental mistakes in both observational and theoretical work. See's problems were the result of personality traits and consequently are no reflection one way or the other on his education at the University of Missouri. See's later relations with the University at times became extremely unpleasant, but the incidents were handled as tactfully as could be under the circumstances.

For the most part specific sources of information are indicated in the text, although I have not tried to note every reference as would have been necessary were this a more formal document. The major sources of information have been tabulated in the reference list.
Special thanks go to the staff of the Western Historical Manuscript and Missouri Historical Society Joint Collection for illuminating the mysteries of archival cataloging, and to Mrs. Doris Davis for her quick and efficient typing of this manuscript through its numerous stages of revision. I also wish to thank Dr. John Lankford for his comments on an earlier draft of this manuscript.
THE EARLY YEARS

Astronomy as part of the curriculum of the University of Missouri goes back to the original beginnings of the institution. The University was founded in 1839 under the Geyer Act, with a general plan based after that of Thomas Jefferson and the University of Virginia. In the first few years, however, the actual teaching was done by the faculty of the old Columbia College. The Geyer Act was unworkable due to its complexity and was rescinded by 1843 when the true organization of the University was accomplished. The University faculty of 5 departments with a professor for each was organized in that year under President Lathrop. The departments were Ethics, History, Civil Polity, and Political Economy; Metaphysics, Logic, Rhetoric, and English Literature; Ancient and Modern Languages and Literature; Mathematics, Natural Philosophy, and Astronomy; and Chemistry, Mineralogy, Geology, Botany, Natural History, and Physiology. William Wilson Hudson was appointed to the chair of the Mathematics, Natural Philosophy, and Astronomy.

Hudson was probably the strongest continuing influence on the University in its first two decades and later (1855-1859) would become its third president. He had been born in Virginia (date unknown even to himself) and was a graduate of Yale (A.M.). He had spent three years as a professor of science at the University of Alabama in Tuscaloosa, coming to Columbia, Missouri, in 1840. It is possible that this move occurred because of his interest in the new University which was in the process of being established. It was Hudson's "lively interest...in astronomy" that led to the addition of an observatory to the small physical plant of the University. In the early 1850's the curators had granted funds for the acquisition of scientific instruments; a large part of these funds had been used for astronomical equipment which provided the argument for a building to house this apparatus. The hand-written report of the Board of
Curators (filed 30 December 1852) to the governor states:

A great improvement has been made in the department of Astronomy by the erection of an Observatory and the purchase of a fine set of apparatus selected under the vigilant inspection of Professor Hudson the able occupant of that chair. The erection of this building, intended solely for Astronomical purposes, will commence an important era in the teaching of the Starry Science in Missouri. The student can now explore the heavens for himself and demonstrate the text of Astronomy by ocular evidence. It is impossible for us to convey, in suitable language, our high estimate of the value of this beautiful addition to the institution. For the erection of this building and the purchase of apparatus the sum of three thousand dollars has been appropriated. In a very short period of time the instruments will be permanently secured in the observatory, and increased efficiency be assured to the labors of the accomplished gentleman who has it in charge.

The building was completed in 1853 or 1854 (sources differ) at a cost of $1100 which included several small telescopes - the observatory was an "outstanding addition" to the facilities of the young University. The engineering building now stands on the site of the original observatory.

Hudson apparently had an excellent reputation as a teacher of natural philosophy, astronomy, and engineering and his abilities were further reflected by his administration as University president (1856-1859) during which time there was an "unmistakable improvement in administrative efficiency." While president he gave up his duties as teacher of Mathematics for which a full professorship then was established (the faculty was enlarged to seven professorships), but he retained the chair of Natural Philosophy, Astronomy, and Engineering (the latter a new subject at the University). The University Catalogue of 1857, which is the first catalogue to detail departments and curricula in the fashion of more modern catalogues, describes the work of the "Physics, Astronomy and Engineering" department: "In this Department instruction is given to the Junior and Senior classes. The juniors commence with the theory of Natural Philosophy, which they learn by recitations of a textbook. After they have made some progress in the theory, lectures are delivered with experiments illustrating theoretical principles, and applying them to the
practical and useful purposes of life. The Seniors pursue a like course in Astronomy. After mastering the theory of the subject in the recitation room they go to the Observatory, and apply their theories to practice in the determination of such useful elements as latitude, longitude, time of day, variation of the magnetic needle, etc., etc."

The Observatory continued to be Hudson's "pride and joy." When Hudson revised the college catalogue, in part to increase the public awareness of the University but also to elicit interest so as to increase the enrollment, he showed the Observatory both in a campus view which also included the main University building and in the form of a cross-sectional view. A list of the more important instruments was given in the description of the Observatory.

Hudson died 14 June 1859 after a long-term illness. His tenure as president showed a great improvement in the finances, equipment, and the library of the University. Not so successful had been the efforts to increase enrollment; the students numbered only 36 as compared to a previous high of 52. Hudson's death left the University future uncertain due to factional infighting for the control of the institution. His chair remained vacant although there occurred some reorganization of the faculty. Tied in with the factionalism was the need to find a new president. In January 1860 these problems were swept aside when the state assembly appointed a new Board of Curators who immediately took charge. They nullified the faculty reorganization which had occurred at the time of Hudson's death and instituted their own changes which left the University again with five professorships: Mathematics and Astronomy; all other sciences; Ancient Languages (including Latin and Greek); English and Moral and Intellectual Philosophy; and Political Science. A second meeting of the Board of Curators in May 1860 elected practically a new faculty. Benjamin B. Minor of Virginia was elected president of the University and Edward F. Fristoe of
Columbia College, Washington, D.C., was elected to the chair of Mathematics and Astronomy.

Under Fristoe the course work of Astronomy continued to emphasize practical work. There were two courses, one in Physical Astronomy which discussed the "most important propositions in Universal Gravitation." The course in Practical Astronomy included the use of instruments, observations of the sun, moon and planets, and the determination of latitude and longitude. Olmsted's *Astronomy* was the textbook and reference was made to Norton, Herschel, and others as necessary.

Fristoe was at the University little over a year, leaving 25 February 1862 to join the Confederate army. This action may have been precipitated by the arrest of his wife only a few days earlier for waving a black flag and cheering Jefferson Davis when a detachment of Federal troops passed by. The Board of Curators, however, hesitated to declare his position open and instead, using the unfavorable financial condition of the University as an excuse, discontinued the offices of all faculty and stopped their salaries. The faculty were not consulted prior to this action, which probably was not warranted in spite of current difficulties. Thirteen years later the University of Missouri paid Fristoe $417 for the salary due him.

By 1865 the University was back to a more normal operation and Lathrop was again president with a new reorganization of the faculty. Carr W. Pritchett was elected to, but declined, the post of Mathematics, Astronomy, and Engineering (three years later he would found Pritchett College in Glasgow, Missouri, and initiate the Morrison Observatory in 1875). In December 1865 the position was given to Joseph Ficklin who would stay with the University until his death 6 September 1887.

Joseph Ficklin was born in Winchester, Kentucky, on 9 September 1833.
Growing up on a farm, he was largely self-educated, but adequately enough to teach school in New Madrid, Missouri, for a short time. Ficklin then entered college, receiving a Bachelor of Arts degree from Masonic College in Lexington, Missouri, although he apparently had not completed degree requirements due to financial reasons. He came to Columbia in 1864 to teach mathematics at Christian Female College. Later after joining the University of Missouri faculty, he was awarded an honorary Master of Arts degree by this institution and in 1874 earned a Ph.D. from the University of Wisconsin as well as an LL.D. in 1884.

According to W. L. Webb in his biography of T. J. J. See, Ficklin "was a quiet man, of slow methodical habits, but an excellent teacher, and a very clear-headed mathematician. He was kind and gentle, but not very intimate with the students. When, however, he came to know the serious turn of a student he would take a deep interest in him."

His major efforts were in mathematics in which he published several well-received textbooks, although he was also a master of the use of the telescope.

Ficklin apparently also considered writing a textbook on astronomy. A reply (in the Ficklin Letters of the Ellis Library Joint Collection) from friend David Trowbridge, (Hector, New York), dated 26 July 1867, states: "In relation to your project of writing a textbook on astronomy, I will say that I think you well qualified, but could you not spend your time and energies to better advantage to yourself and public than writing a series of Arithmetics? I think you could write good one, but we have many good ones now. We have not many good works on Astronomy of the character you propose to write. I do not know of a single one." Correspondence five years later from Mr. C. B. Richardson, Vice President of the University Publishing Company, shows an acceptance of
Ficklin's proposal to write the book, but the project apparently never came to fruition.

The astronomical curriculum continued its orientation around the use of instruments to determine time of day, latitude, longitude, and so forth. In this era the determination of time was an important duty at any observatory for standardization of time and time zones had not come into use. And in fact the keeping of time could be confusing; the different railroads which were spreading out across the country adopted their own time standards which often did not agree. Apparently data from the early observatory on campus were important for the time keeping of local railroads, but ultimately this would change. In 1870 Charles F. Dorvel of Saratoga Springs made the successful proposal for "A System of National Time for Railroads" which led to the present time zones. Time keeping duties at a national level were assigned to the Naval Observatory in Washington D.C. With telegraph lines across the country, any locale could keep its time synchronized with the new national standards; hence, the importance of time observations at small observatories was greatly diminished, though this would not occur without protest.

It was at the stimulus of Ficklin that a new, larger telescope was acquired for the University. The old telescope had been in use ever since its purchase, but with increasing emphasis on science courses, Ficklin felt the old telescope inadequate. He knew of a larger instrument that Shelby College of Shelbyville, Kentucky, had for sale or exchange. Ficklin visited Shelbyville and arranged an exchange and Samuel S. Laws, the president of the University, paid the $500 difference in price out of his own pocket. The observatory building was moved to the northeast part of the campus and was reconstructed for the larger telescope which was mounted 13 March 1880. (One hundred years later, the centennial of the Laws Observatory would be forgotten and ignored at the
University, although subsequent curiosity would inspire the writing of this manuscript. All things considered, this would be an improvement over the events which would occur at the also forgotten centennial anniversary of the founding of the original Observatory.) Laws also paid the $2000 moving cost for the telescope building. Ficklin then proposed and the Board of Curators approved the naming of the observatory after Laws. In addition the building housed a portrait of Laws (who selected the artist) and an annual medal for excellence in astronomy was provided. The present location of the portrait is unknown, but the Medal's history can be detailed.

The Laws Astronomical Medal was one of the first awards for scholarship at the University of Missouri. This award was to be "offered annually at Commencement to the student who stands highest in Astronomy, and has at the same time attained a high average of general scholarship. An original thesis written on some astronomical subject, and showing capacity for scientific investigation, is required."

In addition, according to the minutes of the Board of Curators for 2 June 1880, the aspirant had to write a supplementary thesis "vindicating the motto 'The Heavens declare the glory of God.'" This work also to be original, and both theses in the handwriting of the applicant "shall be preserved in the archives of the observatory and when practicable published for its benefit." Originally the awarding committee for the Laws Medal consisted of the heads of the departments of science and the department of English. The University Executive Board, 1 August 1894, amended this latter provision, to make the committee consist of only the professors of Astronomy, Mathematics, and Physics, but added the caution, "The medal shall in no case be awarded for a thesis of inferior literary quality." On one side of the gold medal was a figure of the Observatory with the inscription "The Heavens Declare the Glory of
God." On the opposite side was a likeness of Dr. Laws. Although the medal was in honor of President Laws, after he was forced from his position in 1889, there appears to have been some attempt to rename the medal the "Missouri University Astronomical Medal." University records shows that these early medals were obtained at a cost of $19 each.

Although this award for scholarship must have carried significant prestige in the very small student body, only a few medals were awarded (this record may be incomplete for much of the University documentation prior to 1892 was destroyed during the fire in the main academic building of the University. The present collections of Commencement and other records in Ellis Library and in the Missouri Historical Society Library have not been restored completely from other sources. Unfortunately the annual University Catalogues do not always record whether or not an award was made nor to whom an award went.) The first award of which I am aware went to an engineering student in 1883, Sterling Price Reynolds of Callaway County. In 1889 Thomas Jefferson Jackson See received the award on the basis of a written thesis, Origin of Binary Stars, which he also presented orally at that year's commencement ceremony. Copies of this thesis survive as See had the work published by the Herald Printers of Columbia, presumably at his own expense. Another engineering student, Charles Page Williams, received the award the following year for his paper and oral presentation on Solar Heat. In 1892, John Nelson Fellows discussed his thesis, The Meteoritic Hypothesis, on the day of commencement. It is curious to note that after this time Professor Milton Updegraff, an astronomer, joined the faculty and under him there appear to have been no recommendations for award of the astronomical medal. (In one copy of the 2 June 1897 Commencements in Ellis Library, however, there is a penciled correction that Hugh Allison Smith actually received the medal that year. I have found no other documentation to
confirm this.)

In later years, a few Laws Astronomical Medals would go to Eli Stuart Haynes (1907), Harlow Shapley (1910), Edith Eleanor Cummings (1916) (all awards for theses written to complete the requirements for Masters Degrees in Astronomy), and to Richard Maury Emberson, a student of Physics and astronomy assistant in 1932. (Emberson had wanted to do astronomy, but actually wrote an optics thesis under the direction of Herbert Reese.)

The Laws Astronomical Medal continued to be listed in the University Catalogue until the late 1940's, and in 1949, Prof. E. S. Haynes recommended another Physics graduate student Joseph W. Chamberlain for the award for his work entitled The Orbit of the Comet Johnson, 1948f. The last documented record referring to the Laws Medal in the Laws Observatory Papers is a letter from Frank Edmonds to Physics Department Chairman H.E. Hammond on 18 April 1952. Edmonds suggested that the provisions of this award be changed so that either a cash award or an award of books be given to a meritorious undergraduate: "I believe this is more in accord with the original purpose of the award." In general, it appears about this time that most University awards of this nature were replaced with academic fellowships, but the Laws award quietly ceased to exist.

The few awards over the early years of this century when an astronomical degree program existed is elegant testimony to the very small number of students who actually were enrolled in the program. Yet although the number of awards were small, they were given to students of high intellectual quality. Haynes and Fellows later joined the University of Missouri faculty. Cummings continued her work at Lick Observatory and Shapley, Williams, Emberson, and Chamberlain pursued long successful careers.

Apparently, according to Webb, Ficklin had been "tenacious ... in holding
on to the personal supervision of the Observatory," but before his death he had been sufficiently impressed with the student See, that he gave See the keys to the Observatory and "invited him to make free use of all the instruments." See spent considerable time including the summers of his last two years before graduation at the Observatory, but there exists little record of what observations were done as documents were probably destroyed in the fire of 1892. The one exception appears to be a copy of a typed manuscript in the Laws Observatory Papers by See entitled "Report of the Determination of the Latitude of the Laws Observatory, University of the State of Missouri, Columbia, Mo., made by T.J.J. See, Class, '89, by Reamur's Method, June 16 - August 14, 1887, resulting in \( \Phi = 38^0 56' 51.8" \)." Although he never held an official position, See would claim years later that he was in charge of the Laws Observatory (and he may very well have been) during these two years.

The University Catalogues do not mention See at all. For 1884/5, the Observatory is well described in a section under the School of Mathematics and Astronomy. Ficklin is in charge with three assistants listed—Thomas J. Lowry, Professor of Civil Engineering and Dean of the Engineering Faculty, William A. Cauthorn, a Mathematician, and W. C. Tindall, also Assistant Professor of Mathematics. Ficklin died in the summer of 1887 and it is somewhat unclear who succeeded him in charge of Astronomy and the Observatory at the University. Professor William Benjamin Smith had been in charge of Physics, but was transferred to the chair of Mathematics and Astronomy. After Ficklin's death, the 1887/8 University Catalogue gives Thomas J. Lowry as Director of the Observatory, and in addition to Cauthorn and Tindall, are added Assistant Professor of Physics and Engineering W. H. Schuermann and Instructor of Zoology and Geology W. W. Clendenin as his assistants. In the next year the Catalogue is less clear as to authority, for the Observatory description is much reduced
within the section on the School of Mathematics and Astronomy. Professor William B. Smith and Assistant Professor Cauthorn and Tindall are given as the faculty but without specific designation as to who is responsible for the observatory. In the following year, Clendenin, now an Assistant Professor of Geology and Mineralogy, has been added to the School of Mathematics and Astronomy. Only in the 1890/1 Catalogue is an Observatory Director specifically named and this is the newly arrived Milton Updegraff who was also an Assistant Professor of Mathematics and Astronomy. Updegraff, in his paper of 1894, states that William Cauthorn was in charge of the observatory between the time of Ficklin's death and the appointment of Updegraff to the Directorship.

The impression one gains is that while Ficklin was alive, the telescope was clearly in his charge. The chore of managing the facility may not have fallen onto a willing faculty member after Ficklin's death and into this vacuum may have stepped the very willing student See.
THE LAWS OBSERVATORY

Fortunately there exist several documents which give us an idea of the original observatory and its later modifications. These include descriptions published in the University Catalogue, a paper published by the Academy of Science of St. Louis by Professor Updegraff, an Observatory Report by Professor Seares in the Publications of the Astronomical Society of the Pacific in 1906, and descriptions in several of the Laws Observatory Bulletins.

The original observatory is of some historical significance for it was one of the first observatories to be built west of the Allegheny Mountains and for many years was the only astronomical observatory in the United States west of the Mississippi River. The building, which later would be moved and remodeled to house a larger telescope, stood where the Engineering building now stands. It was built of wood, 44 feet long and 14 feet wide and was completed in the spring of 1853 at a cost of $1150. This building was divided into two parts, a transit room of dimension 14 by 28 feet and a tower 15 feet high and 14 by 14 feet in size. This tower was topped by a cone which revolved on solid wooden ("lignum vitae") balls. The University's first telescope was housed in this tower and stood on a pier of masonry to isolate it from vibrations induced in the surrounding building. The telescope was an equatorially mounted refractor built by Henry Fitz of New York, with an aperture of 4 1/16 inches and a focal length of 5 feet 4 inches. The telescope was also provided with a smaller finder telescope and a number of eye pieces with powers ranging from 30 to 240. "A sidereal motion (was) given to the telescope by means of an endless screw attached to the hour circle, and moved by hand."

In the transit room, again mounted on suitable piers set six feet into the ground and mechanically isolated from the rest of the building, were several instruments. The first was a 2 1/10 inch aperture transit instrument by Brunner
A woodcut (University Catalogue of 1868) showing a view of the early University campus.
The Observatory fronts east and is 44x14x14. (See Catalogue, 1876-7, pp. 33-39.)

1. The Equatorial room, which contains an Equatorial Telescope, by Fritz of New York.

2. The Transit room, which contains (a) a Sideral Clock, by Stokel of New York, and a Solar Clock, by Ross of Philadelphia; (b) a Transit Circle, by Brunner of Paris; (c) an Altitude and Azimuth Instrument, by Simms of London; and (d) a Transit Theodolite, by GreeG of New York.

Besides the foregoing instruments, the outfit includes a sextant, mercurial horizon, barometers and thermometers.

The roof of the Equatorial room is a cone, which revolves on lignum vitae balls, and is confined to the building only by its gravity. The roofs of both rooms are intersected by shuttered slots, for the convenience of observation. The instruments stand on stone slabs, which rest on pillars that descend about six feet into the ground, and have no connection with the floors.

By means of these instruments, which have recently been put in good repair and working order the student is enabled to gain an insight into the important practical work of Modern Astronomy.

A cross-sectional view of the original Observatory, from the University Catalogue of 1868.
Department of Mathematics, Mechanical Philosophy and Astronomy.

JOSEPH FICKLIN, A.M.
The studies in this Department are pursued in the following order:

FRESHMAN CLASS.
First Semester.—Loomis' Algebra.
Second Semester.—Loomis' Geometry.

SOPHOMORE CLASS.
First Semester.—Loomis' Trigonometry with its application to Heights and Distances, Mensuration, Surveying and Navigation.
Second Semester.—Loomis' Analytical Geometry.

JUNIOR CLASS.
Second Semester.—Snell's Olmsted's Astronomy.

SENIOR CLASS.
First Semester.—Loomis' Differential and Integral Calculus.
The outfit of Instruments and other facilities for illustrating the principles of Natural Philosophy are full and complete.
The adjustment and use of the Quadrant, Compass, Leveling Instrument and Theodolite, are fully explained, and illustrated by practice in the field.

Students in Astronomy, after mastering the theory of the subject in the recitation room, are required to go to the Observatory and apply their theories to practice in the determination of Latitude, Longitude, Right Ascension, time of day, Variation of the Magnetic Needle, &c.

Special attention is given to the mental discipline of the student. The development of the intellectual powers, and the formation and cultivation of correct habits of thinking and reasoning, by a constant reference to the Logic and Philosophy of Mathematics, are made the paramount objects of every recitation.

Prominence is also given to the great practical utility of Mathematics. As far as possible, every principle demonstrated is also illustrated by some useful application of it to the arts.

The recitations are conducted with the aid of well selected text books, and such additional illustrations and explanations as may be necessary, are given, in order to impart to the student a thorough philosophical and practical knowledge of all the subjects taught.

Original problems in the various branches are given to the student to test his knowledge of the subject, and to make him self-reliant and independent.

During the course, lectures are delivered on the Philosophy, Utility and History of Mathematics.

OBSERVATORY.
The Observatory stands west of the University edifice. It is forty-four feet long, fourteen feet wide, fourteen feet high in the Equatorial room, and ten feet high in the Transit room.
The roof of the Equatorial room is a cone, which revolves on eight lignum vitae balls, and is confined to the building only by its gravity. The roofs of both rooms are intersected by shutters for the convenience of observation. The instruments stand on stone slabs, which rest on pillars that descend about six feet into the ground, and have no connection with the floors.
The Equatorial room contains an Equatorial Telescope, by Fitz of New York. The Transit room contains a Sidereal Clock, a Transit Circle, an Altitude and Azimuth Instrument, and a Transit Theodolite. Besides the foregoing Instruments the outfit includes a Sextant, Mercurial Horizon, Barometers and Thermometers.

By means of these instruments the student is enabled to gain an insight into the important practical work of Modern Astronomy.

From the University Catalogue of 1868.
of Paris. This had a 23 inch focal length and a 10 1/2 inch circle with 5 arcminute graduations. With two verniers and microscopes, its position could be determined with an accuracy of 3 arcseconds. There was also an altitude and azimuth instrument by Simms of London which had horizontal (10 1/2 inch diameter) and vertical (8 inch diameter) setting circles. In addition, there were a theodolite of 1 3/8 inch aperture, 18 inch focal length, by Gregg and Rupp of New York, a sextant, a mercurial horizon, a barometer, and thermometers. Two clocks, one a sidereal clock by Stokel of New York, and the other a mean or solar time clock by Riggs of Philadelphia also were kept in the transit room. This description of the Observatory appears first in the 1857 University Catalogue and was repeated verbatim in 1858, but was dropped from the Catalogue in successive years. Updegraff obviously used this source to write his article (his draft article is in the Laws Observatory Papers and includes a tear sheet from the University Catalogue).

The equipment of the Observatory was unchanged until 1878, when the original sidereal clock was replaced by one from Gregg and Rupp of New York (described as having a mercury pendulum) and the altitude and azimuth instrument by Simms was replaced by a similar instrument of 2 1/8 inch aperture made by E. and G. W. Blunt of New York. The 1878/9 Catalogue describes a 22 inch focal length and 12 inch setting circles for good accuracy of positional setting. Updegraff suspected, however, that in reality no change, as implied by the University Catalogue of 1878, actually occurred, but rather that "the names of the makers are incorrectly stated in the earlier University catalogues." We note, though, that in the previous years Catalogue 1887/8, under "Wants of the Department," Ficklin listed "only a few of those that are more pressing." He wrote, "The instrument equipment of the Observatory is deficient in some respects. We need a Chronograph, Micrometer, eye-pieces for the Telescope and
Transit Instrument, a collimating eye-piece for the Transit Instrument, a Chronometer, and a Solar Clock. The cost of these instruments would be about $800, and if the finances of the University are in a condition to bear it, I respectively suggest that an appropriation of that amount be made for the purpose of purchasing them. With these instruments, the Observatory would be well equipped for purposes of instruction" (the italics are Ficklin's). It may indeed be the case that Ficklin's request was granted and new equipment purchased.

As might be expected, Updegraff states, "The old Observatory was of course used chiefly for the purpose of instruction." Little is known of what observations may have been done, other than observations of the transit of Mercury on 6 May 1878: "I have forwarded a report of our observations to the Superintendent of the U. S. Naval Observatory at Washington," reported Ficklin in the 1877/8 University Catalogue. Also in that year the longitude of the Observatory was approximately determined by comparison of the local time as observed with the transit instrument with time signals sent by telegraph from the Naval Observatory in Washington, D. C. Meridian altitudes of the sun and various stars were also observed to obtain an approximate latitude for the Observatory.

In January 1880, the Fitz telescope and $500 were given in exchange for the 7 1/2 inch equatorial refractor of the Shelby College of Shelbyville, Kentucky. The original observatory building was moved to a better site on the northeast side of campus (where now sits Neff Hall). As the old conical dome was too small for the new instrument (its focal length is 10 feet 8 inches), a new octagonal tower with a hemispherical dome was constructed on the east end of the transit room. The new telescope was repaired and mounted on 13 March 1880 under the direction of Professor Ficklin. The new dome was of a more modern design as it
rotated on six wheels which ran on a circular iron rail. The movement was accomplished by turning a handcrank that was geared to the dome.

The telescope was mounted on a wooden stand which rested on the brick pier in the tower. The tower was 18 feet in diameter and about the same dimension high. The apex of the dome was about 14 feet about the level of the floor. The brick pier had the shape of a square pyramid and rose to within two feet of the floor of the dome. It was covered by a capstone 4 feet square and 5 inches thick on which rested the wooden stand of the telescope.

The telescope itself consisted of a tube of polished mahogany with all fittings of either steel or brass. Updegraff further describes the telescope, "The mechanical work is of the finest character throughout. Both lenses of the object glass are free from cracks and scratches and seem to be as good as when new. Yet both the optical quality of the telescope and the character of the mounting leave much to be desired as compared with instruments of more modern design." The Biennial Report of the Board of Curators for the 2 years ending 31 December 1890 had recommended a special appropriation of $600 for a new lens for the telescope, but this apparently was not granted by the state legislature, although a second request for $800 for a new office room adjoining the "unheated" Observatory building did result in an addition.

By the time the University of Missouri acquired this telescope, it had already had a productive life. It was originally ordered in 1848 from Merz and Mahler (the telescope was actually inscribed Merz und Söhne) of Munich, Germany, by Shelby College which had established an observatory the previous year. For its era it was an excellent instrument - Merz and Mahler were successors to the establishment of Fraunhofer who had been regarded as an optical genius, although he is now more remembered for his discovery of absorption lines in the solar spectrum. Its price in Germany was $3500, but the
cost of transportation and mounting in Shelbyville, Kentucky, brought the total to about $4000. The telescope arrived in November 1850 and was mounted under the direction of Professor Joseph Winlock.

Winlock, however, was a man of ability and soon left Shelby College (in 1852) to work in the Nautical Almanac office in Cambridge, Massachusetts. Winlock apparently was not replaced at Shelby College for he was allowed to borrow the telescope for his personal use. With Benjamin A. Gould, he established the Cloverden Observatory in Cambridge. The two of them used the instrument for cometary and planetary observations, the results of which were published in the Astronomical Journal which Gould had founded. By 1856 the telescope had been returned to Kentucky. In 1867, Professor Winlock, now Director of the Harvard College Observatory, and his assistants returned to Shelbyville to use the telescope in observations of the total eclipse of the sun which occurred on August 7 of that year.

The 1867 eclipse is of some note for it was only the third total eclipse of the century visible in the United States and the first during which there were experienced astronomers with the proper equipment for its observation. Winlock at the instigation of the American Philosophical Society of Philadelphia and the American Academy of Arts and Sciences in Boston, drew up a petition to Congress to gain financial support for observations of the eclipse. As a result expeditions were sent by the Nautical Almanac Office and the U.S. Naval Observatory. Winlock led a Harvard party of ten persons who were stationed in various places in Kentucky. The primary aim of work at Shelbyville was to study the spectrum of solar prominences and to photograph the solar corona.

Shelby College failed sometime after the Winlock visit, and the building was taken over as a public school which by 1879 had serious financial problems. The trustees thus voted to sell the telescope although there was a strong public
feeling to keep the instrument. Because of this the monetary offer proposed by Professor Ficklin together with the offer of the smaller telescope in trade was an attractive proposition which was readily accepted.

The funds paid to Shelby College and the $2000 necessary to move and refurbish the building for the larger telescope were paid by President Laws. Use of his personal funds was strong indication of President Laws' interest and dedication to the University. It is likely that the telescope would have been lost had the University waited to gain an appropriation of funds by the Board of Curators or by the state legislature. With minor exception, Laws never recovered these and other expenses during his administration. In 1901, he presented a claim of $3000.00 to Governor Dockery's administration (apparently for expenses related to work on the President's house) which was allowed by the legislature "on account." (An inquiry to Mr. Frank Whelan, Assistant Archivist of the State of Missouri, produced the following response: "The term on account appears to mean that the money is on deposit and can be drawn by an individual or group so named by the Legislature. President Laws' problems in getting these funds is unknown. There is no record in the Official House and Senate Journals for 1901 of any money being requested for him. Any written record may have been destroyed in the Capitol fire of 1911.") When Laws wrote Professor Robert H. Baker on 21 January 1919 he estimated "that balance, with interest, must be near ten thousand dollars." Continuing, "This is an honest and valid claim. I now give it to the observatory.... I do hope the legislature will justly and generously allow you this claim."

The arrival of the telescope in Columbia was greeted with acclaim. The Columbia Statesman wrote (12 March 1880) that at the time of its purchase by Shelby College, it was the fourth largest telescope in America. The paper did not note that in 1880, however, there were 24 larger instruments in the United
States alone, the largest of which had an objective of 26 inches. With the new telescope and refurbished observatory and probably some fudging on evaluation, the newspaper further claimed, "The value of the University property is now greater than that of Yale College..."

The Laws Observatory is shown in the photographs on the next pages taken from various published sources. A woodcut taken from the University Catalogue of 1884/5 also illustrates the appearance of the 7 1/2 inch telescope. The same catalogue, in addition to the telescope, lists the Observatory equipment as including the following:

1. Auxilary equipment for the telescope: filar and annular micrometers; 14 eyepieces with a range of powers between 70 and 1016; reflecting prism; sunshades; a finder telescope of aperture 1 7/8 inches and focal length of 17 1/2 inches made by Alvan Clark and Sons of Cambridgeport, Massachusetts. The telescope was equipped with an hour circle of 10 inches diameter and a declination circle of 15 inches diameter, each equipped with two verniers read by reading microscopes which were made by R. B. Gans of Boone County, Missouri. The telescope was also equipped by a driving clock which, no doubt, was a significant improvement over the hand driven mechanism of the former telescope.

2. The Meridian Circle (number 4 on the Observatory cross-section) made by Brunner of Paris about 1850. This instrument's usefulness "has been greatly increased by the addition of a filar micrometer, made by W. T. Gregg, of New York." Updegraff's (1894) comments on this transit instrument are less favorable. He states, "The micrometer with which the instrument is provided is so constructed as to be practically useless." Also, "The levels which were furnished with the instrument by the maker are almost worthless for purposes of precision on account of irregularity in
Two views of the Laws Observatory on the site now occupied by Neff Hall. Both photographs date from approximately 1890. The upper view is from the biography of T.J.J. See written by W. L. Webb and the lower view is a photograph published by Updegraff in 1894.
A cross-section of the Observatory building at its second location on the northeast side of the campus. The transit room (B) and the alt-azimuth room (C) form the original building, to which the tower (A) was added to house the new telescope (1). The observatory also housed two clocks (5 and 6), a meridian circle (4), an alt-azimuth instrument (7), and a transit theodolite (3).
A woodcut from the University Catalogue showing the configuration of the Merz telescope. This figure was not of the actual University telescope, but was taken from Loomis's Practical Astronomy: "One would infer that (the figure) must have been intended to represent our instrument," wrote Professor Ficklin.
### Astronomical Observatories in the United States.

<table>
<thead>
<tr>
<th>Place</th>
<th>Name</th>
<th>Director</th>
<th>Telescope</th>
<th>Aper. inch</th>
<th>Powers</th>
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<td>Speaker</td>
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<td>Washington, D. C.</td>
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* Clark. † Eaton.

A list of astronomical observatories in the United States at the time of the establishment of the Laws Observatory in "Columbus, Mo." From the Sidereal Messenger, 1, 8, 1882.
the bore of the tubes." The leveling problem was corrected in April, 1891, by replacement of these parts with "ones of excellent quality made by Fauth & Co." Updegraff was also forced to make other modifications of the instrument in order to make accurate observations with it.

3. The Alt-Azimuth Instrument (7) made by E. and G. W. Blunt of New York. At the original Observatory site, this instrument had been mounted in the transit room from which the sky was observed through a north-south oriented slit, thus allowing observations only at the meridian. It was now placed in the old dome at the west end of the building and could be used to observe any point above the horizon.

4. The transit Theodolite (3) made by Gregg and Rupp of New York. To this instrument there also belonged a strong portable tripod for field work.


6. A Solar Clock by Gregg and Rupp of New York (6). This clock formerly had been for sidereal time, but had been converted to mean time by lengthening the pendulum.

7. A New Sidereal Clock (5) which is the clock by Fauth and Company of Washington, D. C., that is still in the possession of the Department of Physics. This clock was equipped with a "break-circuit attachment" which could thus send a time signal which would be recorded on a sheet of paper on the Chronograph.

8. The Chronograph (2), also built by Fauth and Company, was mounted on a brick pier near the eastern end of the transit room. Its cylinder was 14 inches long and 7 inches in diameter and revolved once in a sidereal minute, although this rate could be doubled by the push of a button. A time signal was recorded every second as well as the signals from the observer working with the Meridian Circle. The pen carriage was moved by a
screw along the length of the cylinder so that two hours of observations could be recorded on one sheet of paper wrapped around the cylinder.

9. A Spectroscope which could be used with either a diffraction grating or a prism consisted of a collimator and a view telescope with objectives of 1 1/2 inches aperture and 12 inches focal length. The grating, 9/10 inch square, had 17,296 lines to the inch, and was ruled by Chapman on Rutherford's engine. The collimator could be connected with the draw-tube of the equatorial telescope by means of four stiff rods. This instrument along with the sidereal clock and chronograph were purchased from Fauth and Company in 1883 for $1010.70.

10. A Mclean Star Spectroscope which consisted of a cylindrical concave lens in front of a direct vision prism. This too could be attached to the equatorial telescope and was noted to be "more convenient than the large spectroscopic."

11. A telegraph connected to the lines of the Western Union Telegraph Company, thus linking the Observatory to almost every other observatory in the country. Electrical signals from the U. S. Naval Observatory could also be received, "thus furnishing the means for illustrating the method of finding the longitude by electric signals."

Updegraff also lists other items which were present at the time of his arrival:

12. A 20-inch celestial globe which had been acquired in 1881.

13. A filar micrometer for use with the equatorial telescope.

During this decade much of the work at the Observatory had to do with the training of students to use the equipment to learn the practices of determining latitude and longitude and time from astronomical observations. During the first year after the arrival of the large telescope in Columbia, Ficklin wrote, "Much of my time during last vacation was occupied in adjusting the Telescope."
My time and energies have been so heavily taxed by class work, that I have not been able to do as much work in the Observatory as I wished to do." However, some "systematic observations extending through a period of several weeks were made on Hartwig's Comet and Swift's comet." These investigations were accomplished with the assistance of Benjamin F. Thomas of the Department of Physics.

In 1881 little was done other than the usual drill for students and time observations. Ficklin did prepare to observe the 7 November transit of Mercury, but clouds ruined the observations. Other work was noted in the Missouri University Review of February 1882 (pg. 59) which included the following notices of Observatory work under "Scientific Notes."

On the nights of Dec. 14th and 21st Prof. Ficklin made a thorough search, with the 7½ inch Mertz refractor, for the outer Satellite of Mars, but the research proved unsuccessful.

After a thorough test Prof. Ficklin pronounces the periscopic eye-pieces, presented to the Observatory by Dr. Laws, a complete success. For observations on comets, nebulae, and clusters of stars, these eye-pieces are superior to all others.

On the 15th of December, 1881, Prof. Ficklin observed a large and interesting Sunspot. He measured its diameter with the micrometer and found it to be 21,160 miles. The nucleus was spanned by an irregular bridge of light. On the 16th the bridge had entirely disappeared.

On the other hand, Ficklin had now been joined in the School of Mathematics and Astronomy by William Cauthorn and Willoughby Cordell Tindell, Assistant Professor and Instructor of Mathematics, respectively. Thomas J. Lowry, Professor of Engineering, and Lieut. John January Hayden, Professor of Military Science and Tactics on assignment from the U.S. Army, were also listed as Observatory assistants this year. As a result, Ficklin was able to write, "With
the present teaching force in this department, I shall be able to devote a large amount of my time to the astronomical work, and thus render the Observatory more serviceable."

The next year Ficklin was able to make an accurate determination of the latitude of the Observatory using observations from a zenith telescope belonging to the U. S. Coast and Geodetic Survey. Again preparations were made for a transit of a planet across the face of the sun, this time Venus on 6 December, but once again clouds completely obscured the event. Observations of the sun were made, especially during April 1882 when solar activity was especially great. The grating spectroscope was mounted on the telescope and filters used to isolate the Hα line to study prominences on the solar limb, as well as associated sunspots. The Missouri University Review (pg. 205) noted later in the year:

**A LARGE SUN SPOT.**

On the morning of Sept. 25th, Prof. Ficklin observed a very interesting group of sun spots near the eastern limb of the sun, and on Sept. 29th he measured with the micrometer the largest spot of the group. Its dimensions were as follows:

- Length of Penumbra: 53504 miles
- Width of Penumbra: 29972 miles
- Length of Nucleus: 22321 miles
- Width of Nucleus: 11684 miles

At Prof. Ficklin's request Prof. Conrad Diehl made a careful drawing of the group to be preserved among the records of the Observatory.

This drawing apparently disappeared long ago, probably in the 1892 fire.

Comet Cruls, an exceptionally bright object, also was observed in late September and early October at the Observatory. Professor B. F. Thomas of the Physics Department using parts of that department's Browning spectroscope
observed its spectrum with the equatorial telescope.

Other than these few observations, the major part of the work actually performed at the Laws Observatory were the standard observations for time, latitude, and student drill.

Over the next few years this appears to have been the pattern with observations of sunspots, solar prominences, comets, and planets occurring as possible along with the student drill and attention paid to visitors to the observatory. The partial solar eclipse of 16 March 1885 was observed as was the lunar eclipse of 23 September of that year. In the following year, "Clouds prevented observations on the solar eclipse of March 5." As far as is known no observations were published in any astronomical journal and the Observatory records apparently no longer exist.

We have already noted the importance of local astronomical observatories in providing accurate time signals for the local standardization of clocks. As might have been expected, after the designation of national time zones, there would be a movement to centralize time service and in 1890 such an effort began. There are no records to show what income the Laws Observatory derived from providing a time service to the local area, but apparently some funds were earned, as W.B. Smith joined with the directors of Morrison Observatory in Glasgow, Missouri, and of Washington University Observatory in St. Louis and of other observatories throughout the country to protest the decision by the U.S. Naval Observatory to supply gratis time service to the Western Union Telegraph Company which in turn would provide time service on a commercial basis to the country. This protest, as submitted to the Secretary of the Navy, was as follows (reproduced from the Sidereal Messenger, 9, 331, 1890):

Memorial to the Secretary of the Navy. April 15, 1890. To the Secretary of the Navy: Sir: Your attention is hereby respectfully called to the injury inflicted upon various Astronomical Observatories in the United States by a practice which has been established
at the U.S. Naval Observatory of supplying the Western Union Telegraph Co. with time signals for commercial use.

For a considerable number of years the signals necessary for the regulation of time-pieces have been derived, in different parts of the country, from the Observatories established in those districts. The sums received in payment for the signals have formed an important portion of the revenues by which the Observatories have been supported. An additional advantage resulting to the Observatories from this system consists in the fact that it thus becomes apparent to the people of each district that the Observatory founded among them is rendering a constant public service. They are consequently led to take a more active interest in astronomical science than would otherwise be the case, and the Observatories must depend upon this interest for the donations and legacies by means of which their scientific researches are supported.

But these astronomical institutions are unfitted for commercial competition with a powerful corporation like the Western Union Telegraph Co. If this corporation undertakes to occupy the field of supplying time signals, and can obtain the same gratuitously from the U.S. Naval Observatory, it is obvious that the local Observatories must abandon the contest, with great damage to their means of support, both direct and indirect, as has been shown above. Such is the actual result of the present policy of the Western Union Telegraph Co., to succeed in which, however, it depends upon the support which it now actually obtains from the U.S. Naval Observatory. That Observatory founded to promote the science of astronomy in this country, now accordingly appears as the means of withdrawing the funds which have hitherto been maintaining that science in many parts of the United States.

The arrangement between the U.S. N. Observatory and the Western Union Telegraph Co. contemplates the distribution of time signals from the Naval Observatory to the entire country. Beside the injustice to private Observatories already alluded to, this plan involves difficulties which will make any such service uncertain and inaccurate as compared with the present automatic service from the private Observatories.

You are therefore requested, by this memorial to consider the system which has been established at the U.S. Naval Observatory, in pursuance of which time signals are given, for commercial use, to the Western Union Telegraph Co., and to cause this practice to cease if you find that it is injurious to the interest of American astronomy. Very respectfully, Edward C. Pickering, Director Harvard College Observatory, Cambridge, Mass.; John K. Rees, Director Columbia College Observatory, New York, N.Y.; G.W. Hough, Director Dearborn Observatory, Evanston, Ills.; Edward S. Holden, Director Lick Observatory, Mount Hamilton, Cal.; Ormond Stone, Director Leander McCormick Observatory, Charlottesville, Va.; Wm. W. Payne, Director Carleton College Observatory, Northfield, Minn.; Frank W. Very, Allegheny Observatory, Allegheny, Pa.; C.A. Young, Director Halstead Observatory, Princeton N.J.; Carr W. Pritchett, Director Morrison Observatory, Glasgow, Mo.; Winslow Upton, Director Observatory Brown University, Providence, R.L.; Lewis Swift, Director Warner Observatory, Rochester, N.Y.; H.A. Howe, Director Chamberlain Observatory, Denver, Col.; J.G. Porter, Director Cincinnati Observatory,
Cincinnati, O.; W.B. Smith, Director Observatory University of Missouri, Columbia, Mo.; H.S. Pritchett, Director Observatory Washington University, St. Louis, Mo.; H.A. Newton, Director Winchester Observatory, Yale University, New Haven, Conn.; E. Colbert, Chicago Tribune, formerly Superintendent Dearborn Observatory, Chicago, I11s.; Chas A. Bacon, Director Smith Observatory, Beloit, Wis.; Wm. A. Rogers, Director Shannon Observatory, Colby University, Waterville, Maine; Edwin Brant Frost, Director Shattuck Observatory, Dartmouth College, Hanover, N.H.; Charles Bruckhalter, Director Chabot Observatory, Oakland, Cal.; and others whose names have been forwarded to Washington.

The Sidereal Messenger (9, 332, 1890) goes on to note, however, that the immediate response to this protest was not favorable:

The above memorial was placed in the hands of Secretary Tracy several weeks ago, and, it is reported that he is in correspondence with the officers of the Western Union Telegraph Company. Some of the persons whose names were signed to this memorial have had conference with the telegraph company, upon the points raised in it, and in every case obtained no satisfaction whatever. We do not expect anything favorable will come of this attempt, for we know too well the present strained relations that exist between the telegraph company and the Government, to believe that it will amount to anything. If this step fails, others will be tried and the case will not be relinquished until justice is done in some way.

And nearly a year later (Sidereal Messenger, 10, 151, 1891), "the working of this mongrel time system..., as was expected, ... proves unworthy of the confidence of those who must have accurate time in business." Furthermore,

As for the time it is a well known fact in observatories that the Western Union Telegraph Company appropriates the local time of local observatories to their own use whenever they care to do so and thus obviate the need of transmitting the Washington time long distances. Astronomers can very easily know when this is done, for they have means of proof, and we know it has been done repeatedly in the west, and local officers of the telegraph company admit it. But the practice of seizing the local time which is the property of local observatories still continues.

This, however, was a fight which the local observatories were destined to lose.

Professor Updegraff took charge of the Observatory about the 1st of July 1890, spending his time to overhaul, clean, and repair the building and the instruments. In addition, by the end of July time observations could be started
with the transit instrument and by November observations with the equatorial telescope were begun. Additional equipment items were obtained for a cost of $350. These included a break-circuit sidereal chronometer by Bond and Son of Boston, a barometer by H. J. Green of Brooklyn, and a set of thermometers from the same manufacturer. In addition a direct line of telegraph wire was run to the Columbia office of the Western Union Telegraph Company, replacing the older inductive coupling with W. U. lines that had been installed some years earlier. "Numerous minor improvements were made in the building and instruments," and a major addition of a 15 by 30 foot office and library room with a basement was added in the summer of 1891 to the western end of the Observatory.

Concerning the quality of this equipment, Updegraff made the following statements: "the Chronograph by Fauth & Co., the Sidereal Break-Circuit Chronometer, by Bond, the Sextant by Blunt, and the Barometer by H. J. Green are in every way first class. The Altitude and Azimuth instrument, Theodolite and Mean Time clock are of inferior quality." But nevertheless, "The smaller instruments and appliances with which the Observatory is provided render its equipment very complete."

In the Observatory Report of 22 November 1890 which Updegraff submitted to William B. Smith, he estimated the total value of the instruments and clocks at $5000; this value would be greater when "the constants and peculiarities" had been determined through a long series of astronomical observations. Nevertheless Updegraff could also come up with an itemized list of necessary repairs and additions totaling $2785.00. One major item which essentially was to become a permanent annual request was replacement of the objective lens of the Merz telescope. In the forty-five years since its construction both the manufacturing techniques for glass and the figuring of lenses had improved significantly. In the first year Updegraff requested $600 for a new objective from Alvan Clark,
the leading U.S. telescope maker. If this amount could not be provided, then Clark would refigure the lens if the glass proved to be good, or this refiguring could be done more cheaply by Mr. R.B. Gans of Boone County. He "is well known here (and) has a telescope at his farm (six miles from Columbia) which he made there himself and which is almost as large as ours and superior to it in quality....With a good lens," Updegraff concluded, "we should have a good telescope."

Some funds were granted the first year, but the major items - a new lens and building repairs - were not. In the next Observatory report, the requests were resubmitted. "A continuance of the liberal policy of the Board toward the Observatory will result in the possession by the University of one of the finest college observatories in the Miss. Valley." By this time, however, Updegraff could also note that there were 58 refractors in the U.S. of larger size and "by far the greater number of these are of better quality."

Although no closer to obtaining funds for the telescope, Updegraff sent the objective lens in 1895 to Alvan Clark for his inspection. Clark replied (27 April 1895) that the objective was "about as good as would be made from the material used. Both glass are somewhat defective. The figure as well as the color correction are quite good, in fact so good that we think it would not be worth while to do anything with the glass."

Updegraff continued his efforts to improve and repair the Laws Observatory facilities, but as to the major items concerning the telescope and the repair of the observatory dome, he never was successful in obtaining money from the University.

While most of Updegraff's time was occupied by teaching, some transit observations and micrometric observations of comets and minor planets were done with some regularity. Work no doubt was strongly disrupted for a year and a
half after the destruction of the main University building on 9 January 1892. The office, library, and basement of the Observatory were used as classrooms as were any other facilities available in Columbia. Forced to work at home, Updegraff complained that "the inconvenience is very great."

In particular one of Updegraff's first duties was to redetermine the latitude and longitude of the observatory. This was done in part by re-discussion of measurements that Ficklin had performed in 1882, but also by new astronomical measurements made with the 2 1/10 inch transit instrument in the Laws Observatory. For determination of the longitude, telegraphic time signals were exchanged with the Observatory of Washington University, St. Louis, on the nights, of 25, 26, 28, and 29 October and 2 November 1891. Updegraff made the observations in Columbia and Professor H. S. Pritchett worked with the Fauth Transit of the Observatory of Washington University. After correction for clock errors and systematic effects of both instrument and observer, Updegraff determined the following position for the west pier of the transit room of the Laws Observatory:

Longitude 6 hours 9 minutes 18.33 ± 0.04 seconds
Latitude 38 degrees 56 minutes 51.70 ± 0.08 seconds

During his 8 years at Laws Observatory, Updegraff found time to accumulate observations to publish 19 short notes and longer scientific papers in professional journals, such as Benjamin Gould's Astronomical Journal and the German published Astronomiche Nachrichten. As early as 1890, however, Updegraff had expressed the desire to initiate a series of publications which would bear the imprint of the University of Missouri Observatory name, but funds were never made available for this purpose until after Updegraff left.

Clearly Updegraff would have preferred to do more observational work, but other duties took priority. "As might be expected the repairs which have been
From the student yearbook of 1894/1895, the Savitar, facing page 100.
underway in the observatory have interfered somewhat with the astronomical work." And then there was the observatory open house on Saturday night - "This work of receiving visitors makes serious inroads on my time and energies but there is some of it which can be hardly avoided." There were also the academic duties. In the Observatory report which appeared in the British journal *Observatory*, 14, 355, 1891, it was noted, "The director's time is largely occupied in the mathematical and astronomical classes of the University." In *Observatory*, 15, 380, 1892: "The time of the Director is largely taken up with class - teaching in the University." And in the third and final report to appear in *Observatory*, 17, 246, 1894, with the reappearance of the name Laws Observatory, the editors wrote, "We hope to hear more of Mr. Updegraff, although he is somewhat hampered with his University duties."

In spite of Updegraff's persistent complaints concerning needed repairs to the observatory building and to the telescope and concerning the non-productive demands on his time, his tenure as director of the Laws Observatory was a major step to making the institution a productive research institution. The size and age of the Merz telescope was a handicap, but many observatories with newer and larger telescopes were much less productive.

Many of the problems about which Updegraff so persistently had complained would continue through the tenure of his successor Frederick Seares. The University financial situation did improve somewhat and Seares was also more willing and able to work under the conditions that prevailed. Those items he requested for improvement of observatory facilities tended to be somewhat less expensive than those requested by Updegraff which often ran to several thousands of dollars. Seares and the Observatory further benefited as the graduate program of the University developed and a few student assistants could be hired to relieve the teaching load on Seares. These assistants further aided in the
observational work and its reduction.

During this period, Seares published only one observatory Report from the Laws Observatory in the Publications of the Astronomical Society of the Pacific in 1903. Besides citing the departmental work in instruction of students, the Department of Astronomy was involved "in the prosecution of such observations as can be made satisfactorily with the equipment of the Laws Observatory." Of the equatorial telescope, Seares wrote, "The objective is of fair quality, although the glass entering into it is somewhat defective. The mounting (of the telescope) is of the original Fraunhofer design..., and, though inconvenient, and in some respects defective, the instrument is, nevertheless, serviceable for many kinds of observations." By this time the old wooden framework which stood on the pier and supported the telescope had been replaced by a castiron column, "which gives the instrument a thoroughly stable foundation." Part of this new mount had been obtained from the Warner and Swasey company; the mount was a standard part of their 8-inch equatorial mounting. The remainder of the mount was constructed in the University shops.

In a letter written to Rober Baker some years later (19 October 1911), Seares was more expressive concerning the state of the Observatory. "I hope that you may have as much pleasure in the work there as I had during the years that I held the position. As you say, the observatory is not what one would call modern," he wrote. As for the main telescope," I am afraid the driving clock of the 7 1/2 inch is hopeless. I never attempted to use it for any purpose except to keep the instrument under way in a rough kind of fashion when visitors were using the instrument."

Seares also had made considerable additions to the equipment of the Observatory with recent purchases of a Pickering stellar photometer made by the Alvan Clark and Sons Corporation and a disk photometer by Brashear. The
Pickering photometer was to be used for systematic observations of variable stars. "Considerable quantities of minor apparatus, such as sextants, artificial horizons, testing instruments, batteries, etc., have also been acquired."

As had occurred a decade earlier with Updegraff, a considerable portion of the time of the first year in Columbia was spent in administrative details and in reorganization of the Observatory. One of Seares' immediate successes in 1901-2 was improvement of the Observatory library, with about 600 books and pamphlets acquired through a gift and about 75 volumes acquired by purchase. By late 1902 in addition to the teaching duties, Seares was beginning to use the Observatory facilities for actual astronomical observations, which included a number of observations of comets. The initial measurements of positions were communicated with other observatories by telegram. Soon thereafter a comprehensive summary of observations together with calculation of an orbit for Comet b 1902 appeared in the first of the Laws Observatory Bulletins.

Seares then turned to a second major effort, the study of the light variation in variable stars. In order to make reliable observations of the light changes Seares first had to investigate the photometers he had purchased, to determine the various instrument constants, and "at the same time, to gain some idea of the precision which they are capable of affording." The results of this work were published in the 7th number of the Laws Observatory Bulletin in 1905 in which also are given descriptions of the two photometers. The disc photometer was a testing device which could be used for the calibration of other optical devices. Essentially by use of a rotating disc from which a number of sector shaped areas were cut away, a source of light could be diminished by a definite amount. By use of this device the absorption wedges of the Pickering photometer would be calibrated.
The Pickering photometer was the device actually used at the telescope in order to measure the apparent luminosity of a star. In the photometer an artificial light source with a series of optical elements was used to produce an artificial star in the field of view of the telescope alongside the image of the real star whose brightness is being determined. The intensity of the artificial star could be varied until its image matched that of the real star. The position of the wedge together with its position for an observation of a star of known brightness then gave the datum required as long as the observer knew the relative difference in absorption between the two wedge positions. In the instrument in use at Laws Observatory, the absorbing wedges were actual wedges of dark glass. To match the apparent color of the artificial star with that of the real star, a "slip of colored glass" would be used to tint the color of the artificial star.

The source of light for the artificial star was a small incandescent lamp, requiring 0.18 amperes at 3.5 volts. The power source was six or eight Edison-Lalande primary cells of 300 ampere-hour capacity. A Weston milammeter was placed in the circuit to reveal any variation of current which would affect the brightness of the light source and hence the final systematic accuracy of stellar measurements. In practice these cells proved to be very satisfactory, operating for days without variations above the level of 1%.

At the telescope, this photometer could be used to observe stars as bright as the seventh magnitude with the artificial star at normal intensity and using the full aperture of the 7½ inch refractor (Seares does not give a faint limit, however). To observe brighter stars, one needed only to diaphragm the telescope to a smaller aperture.

In December 1905 the Observatory also ordered a new photometer, "an automatic registering photometer of the Zöllner-Müller type," manufactured by
A photograph of the Zöllner photometer built by Kandler and Gaertner on the 6-inch equatorial refractor of the Washburn Observatory. The instrument used at Laws Observatory should have been very similar to this. Reproduced from "Stellar Photometry" by C. M. Smith, Popular Astronomy, 6, 117, 1898.
A schematic design of the Zöllner photometer in use at Washburn Observatory. Prism $p^1$ is fixed relative to the mirror $M$ fixed at a 45° angle to the telescope axis and the axis of the nicol prisms. The handle $h$ rotates the prism tube relative to $p^1$; the angle of rotation can be read to give the amount by which the illumination from the lamp has been decreased. The color of the transmitted light can be varied by rotation of prism $p^2$ relative to prism $p^3$ and the thin quartz plate $Q$. 
Campus views of the University of Missouri, Savitar, 11, 238, 1905, showing a view of the Laws Observatory (upper right).
Otto Toepfer & Son of Potsdam at a final cost of $392.40. In this instrument nicol prisms were used to dim the light of the artificial star rather than by use of an absorbing wedge, thus it was sometimes called a polarizing photometer. In addition, the settings of the intensity circle could be recorded on a ribbon of paper, thus eliminating the need of the observer to remove his eye from the telescope eyepiece in order to read the setting. This was accomplished by a lever which pushed the recording ribbon and a strip of carbon paper into contact with a set of raised graduation and index marks on the intensity circle, thus yielding an imprint on the ribbon which could be read at a later time.

In addition in 1907 the Observatory also acquired a new telescope, the 4½ inch equatorial refractor made by the late R. Brown Gans of Boone County. This telescope was a gift of Mr. Hanford Crawford of St. Louis. Although it originally had a portable tripod mounting, it was mounted permanently under the cone-shaped dome of the Observatory where the original 4½ inch telescope obtained by Hudson had been mounted a half century earlier. A new equatorial mounting was obtained from William Gaertner & Co. of Chicago, with other supporting pieces of the mount made in the university shops. The telescope was further modified to mount either the Pickering wedge photometer or the Zöllner-Müller registering photometer, which allowed observation of stars between fifth and tenth magnitude, and it was this telescope which was used for the major portion of the Observatory work.

One final addition to the Observatory in 1907 was the construction of a 30' by 30' classroom, necessary as astronomy class enrollments had been growing under the efforts of Seares (there were 72 students enrolled in five classes during the first semester of the 1907/8 year). With a new coal furnace, for the first time the Observatory also became reasonably comfortable during the cold winter months. These new additions totaled $1199.04 when all bills had been
The two telescopes and the two photometers were used by Seares and his successor, Robert Baker, as well as by students and assistants Haynes, Shapley, Wylie, and Cummings for variable star observations. Their observations and calculations of light curves and other properties of variables stars were published in a long series of papers in the Laws Observatory Bulletins and sometimes elsewhere over the next decade.

In 1916 Baker with his student Edith E. Cummings turned to another method for determination of stellar magnitudes. This was the method of extrafocal photometry. As Baker and Cummings state in the opening of Laws Observatory Bulletin #24, "The application of photography to the precise measurement of star magnitudes has opened an attractive field of investigation that may be entered profitably by an observatory having limited equipment." The method was "simple and direct" and required only a moderate amount of expense for equipment. Basically the photographic plate was exposed in the camera outside the camera's focal position. The resulting stellar images were nearly uniform in intensity and with relative densities which varied according to the relative intensities of the stars which produced the images. A subsequent exposure in a sensitometer, using the daylite northern sky, adds to the plate a series of artificial star disks of known relative magnitudes. A Hartmann Mikrophotometer was employed to measure the densities of both the artificial images and the extrafocal stellar images. The artificial images gave a calibration for the plate and hence the relative magnitudes of the stellar images could be determined.

In order to carry out observations with this technique, a 5-inch photographic doublet telescope was ordered in March of 1912 (cost about $450) and mounted onto the tube of the 7½ inch equatorial refractor. This
The 7 1/2-inch Merz und Söhne refractor, obtained from Shelby High School in Shelbyville, Kentucky, in its dome at the second site of the Observatory on the northeast side of the campus. This photograph was made sometime after 1914 as it shows the Brashear 5-inch camera mounted above the tube of the 7 1/2-inch telescope.
Another view of the same telescope--note the new paint. At the time of this photograph the telescope still had its original mahoghany tube.
The sensitometer and microphotometer used by Baker and Cummings in the extra-focal photometry program.
Examples of some of the results of variable star work at Laws Observatory. From Laws Observatory Bulletin #13 (Seares, 1907) and #20 (Baker, 1913).

Fig. 1—Mean Light-Curve of V Lacertae. Referred to Star δ, 8ω19.

Figure 2. LIGHT CURVE OF Z VULPECULAE

Figure 3. LIGHT CURVE OF RZ SCUTI
was placed behind the set of tubes and the apparatus exposed to the daylite sky, a set of circular images would be exposed, each with a relative density that was proportional to the amount of light allowed to enter the tube via the front plate.

Over the next few years Baker and Cummings completed the reduction of the observational work on a number of variable stars and these results also were published in the Laws Observatory Bulletin, but this appears to have been the last real use of the Laws Observatory for astronomical research. The effectiveness of the Observatory was increasingly impaired due to the growth of trees nearby and by 1919 the Observatory was essentially in use only for classes. (The tree problem was not new. Twenty years earlier, Updegraff wrote (Astronomical Journal, 12, 115, 1892) of his observation of the lunar occultation of the Planet Mars: "Observation of first contact made through a tree-top at low altitude... Observation of second contact lost: the moon and planet being obscured by the leaves of the tree.")

Almost from his arrival, Baker initiated efforts to improve the facilities of the Observatory in a major way, that is, by obtaining a larger telescope to be located away from the main part of campus. Apparently Baker in his early discussions with University administrators had been led to believe there was some possibility of success in this endeavor. In a letter to W.W. Campbell, Lick Observatory, Baker wrote (13 March 1913), "...the attitude of the Curators toward this department is a generous one that promises much in the near future. Since coming here I have seen a half million appropriated for new buildings, and the Observatory is now not far down on the list. A new building and site is [sic] contemplated, and with it a reflector of good size." And in a request for telescope quotations to Mr. James B. Mc Dowell, of the John A. Brashear Co., he further stated (14 March 1913), "I have discussed some of my plans for a new
observatory with the President, and I believe he is much interested. It is very possible that nothing definite will transpire for two or three years, but I want to have the figures fairly well in mind for any occasion that may come up." An earlier inquiry to Frederick Seares concerning sources of financial support during his years was not discouraging either. Replied Seares (19 October 1911), "you will find any amount of polite interest in the affairs of the institution, but it is extremely difficult to carry the matter beyond that point, - at least such was my experience. The University authorities themselves, however, I always found to be most generously inclined within the limits of their financial abilities, which, of course, were necessarily very limited; and I found that in the long run they were really my best resource for such things as we needed in the way of equipment, etc."

One of the possibilities considered was to obtain the facilities of the old Morrison Observatory in Glasgow, Missouri, and for advice again he inquired of Seares (letter 8 November 1912), "Have you ever had dealings with the people at Glasgow? While in Pittsburgh I had this suggested by H.S. Davis, that the Glasgow observatory is something of a white elephant on their hands; that if overtures were properly made they might be willing to turn the apparatus over to the University where it could be used to better advantage. I know there is a 12-inch telescope over there. If there is anything in Davis' suggestion, it might work out this way: that we would need a new observatory to house this telescope, that the new observatory of the State University would be a fitting place to put this telescope, that, given this telescope for the use of students and for general use, the money that would have gone to buy such an instrument might now be turned toward an instrument designed for research, say a 36-inch reflector. This of course is far ahead of the story. I have not spoken to the President about it. I should be grateful for your opinion as to conditions at Glasgow."
And in a third letter to Seares on 29 November 1912, Baker wrote, "Dean Williams has told me about the situation at Glasgow and advised that I visit the observatory as one interested in astronomy and observatories in general. The situation is surely complex, but we must have the 12-inch if there is a way open."

The situation at Glasgow indeed was complex. Pritchett College, originally incorporated in 1868, had been the recipient from Miss Berinice Morrison of trust funds of $100,000 between the years 1875 and 1881. One-half the money, the Morrison Observatory Trust, was for the establishment and maintenance of an astronomical observatory. Part of the trust had been spent in construction of a building and in the purchase of the 12-inch refractor and the remainder was held as an investment to generate interest for the promotion of astronomical observation and research. The remaining half, the Pritchett College Endowment, was held and invested as a permanent endowment for the college which had been founded by astronomer Carr W. Pritchett. This trust, contained a provision that should Pritchett College cease to exist or cease as an educational institute, then the Endowment fund would be added to the Morrison Observatory Trust for the perpetual support of the observatory.

At the time of Baker's initial interest, Pritchett College was already in serious financial trouble for its endowment had never increased beyond the original Morrison gift. The observatory "stood idle and neglected" and there was indication that the trustees of the two trusts did not intend to abide by the trust restrictions on use of the monies for the support of astronomical work.

It was not until five years later, however, that Baker took steps to acquire the facilities of the Morrison Observatory. On 30 August 1918 he wrote to the Board of Curators to request permission to begin negotiations with Mrs.
Berenice Morrison-Fuller concerning the 12-inch refractor. He reviewed the inadequate state of the Laws Observatory, although it was also true that "The Laws Observatory of the University has long held a place among the observatories of America, both in research and in instruction, out of proportion to its meagre equipment." The Board of Curators (2 November 1918) in turn authorized Baker and vice-President C.B. Rollins to secure the transfer of the Morrison Observatory equipment to the University. There is no record of any negotiations that might have taken place. By 1919 the Pritchett College had failed and the income of the trusts and the real property of the college were redirected by the trustees to the use of the Glasgow public school district. Seven years later in 1926 the State of Missouri on behalf of Central College in Fayette brought suit against the board of trustees. The court awarded the Observatory and the remaining funds of the trusts (some $38,356.98 plus interest) to Central College. Ten years later the observatory itself was moved to Fayette.

As early as 1913 plans were being made to move the Laws Observatory. "Our new observatory remains a hope," he wrote to Seares (25 October 1913). "Provision has been made for moving the old dome, with the camera and 7-inch, to the ridge behind the gymnasium. I have delayed this" to study the matter of larger facilities.

But his attempts to develop a more substantial observatory were doomed by circumstances beyond his control. The year 1914 brought World War I in Europe, although Americans were determined to stay uninvolved. The following year the state finances were bad and both the legislature and governor acted drastically to reduce the University budget, to the extent rumours spread in 1916 that the University might not open in the fall. Nevertheless in some senses the Observatory fared very well during this period—in the biennial sessions of 1915, 1917 and 1919 only $90,000 (in 1919) was appropriated for building construction
at Columbia and of this, $15,000 was for construction of a new observatory on a site somewhat distant from the main campus. Had this appropriation occurred a few years earlier, Baker might have succeeded in his goal of obtaining a substantial research instrument - in 1913 his estimates of costs for the telescope optics and mounting, a cement pier on which the telescope would be mounted, and the dome to go over the telescope amounted to only about $20,000. But inflation and the war effort not only had increased the cost of living by a factor of two, but also had affected the costs of telescopes and auxiliary supplies to the extent that even a new mounting for a smaller instrument such as the Morrison 12-inch refractor and the required 26 foot dome in which to house the telescope were beyond the means of the $15,000 appropriation.

In any case, the plot of land on which the Observatory stood was wanted for other university construction. In 1919 the old Observatory, then the oldest building on campus, was razed for the construction of Neff Hall, to be used for the Journalism School (and the first building on campus to come from privately donated funds). The new Observatory was constructed on the south side of the golf links with an appropriation of $19000 from the State Legislature. (Again here we find sources do not agree on the cost of the new Observatory. Stephens in his history states a cost of $15000 whereas $19000 is the figure used in 1920 newspaper accounts.) The site was between the 5th and 7th links of the golf course, where now stands the parking lot of the University Hospital.

The new building, completed in late 1920, was a substantial building with, as before, separate rooms for the main telescope and for the transit instrument (only one instrument was mounted in the new building), and additional rooms for class use, an office and for photographic work space. The allocated funds, however, still meant that shortcuts had to be taken. The old observatory dome, the source of Updegraff's persistent complaints a quarter of a century earlier,
was kept and mounted on the new building and the basement was unfinished which would cause other problems in the future. Baker, never one to give up, made his last recommendation. Writing to President Hill (25 August 1920) he stated, "I wish to recommend that the observatory now being constructed be known as the University of Missouri Observatory (because) an observatory bearing a man's name is handicapped in an attempt to obtain private donations" which now seemed to be the only means to acquire a telescope suitable for modern work. In the enlarged observatory which Baker still had in mind, the old Laws' telescope would play only a small role. In recognition of the ex-University president's role, the dome of the new observatory was named the S.S. Laws Dome. Although the change of name was approved by the Board of Curators, it really affected only the observatory publications. The observatory continued informally to be known as the Laws Observatory, a tradition which is continued to the present day.

After Baker left the University of Missouri, the observatory, now technically no longer the Laws Observatory, was used for continuation of star work by Professor Haynes. "We have chosen this line of research because it may be done with the size telescope that we have and with such auxiliary equipment as we are able to afford... the subject is an important one, since it has a bearing upon stellar development." (University Missourian, 2 August 1923, page 1). A year later the University Missourian (11 June 1924, page 4) wrote "He (Haynes) plans to devote the summer to the organization of some research problems" and "he hoped to be doing more research in the future."

But any effort to do continued work at the new Observatory would be difficult. As early as 1924, Professor Haynes who replaced Baker, wrote to F.M. Tisdel, Dean of Arts and Sciences, that the old dome was "very cumbersome and renders the use of the telescope exceeding difficult. It also leaks copiously
Additional photographs of the Observatory which appeared in the student yearbook.
The Laws Observatory building in its third location, now the site of the University Hospital.
with every hard rain so that both the building and the telescope are being damaged." It was not a matter of repairing the dome which Haynes considered impossible, but one of a new dome. Haynes further pointed out the leakage of water into the basement which resulted in standing puddles and the need for repainting the building. The only success that Haynes seems to have achieved was that the basement was completed with a cement floor. The overall state of the building remained poor and over the years, its lack of use for astronomical purposes (due in good measure to its nearly unusable state) and its isolation from the main part of campus (and Haynes' office in Stewart Hall) would cause other problems.

A complaint in 1933 refers to the golf course people who used the observatory for changing clothes as it was closer to the golf links than the clubhouse. Also the basement was being used by the maintenance department to store fertilizer - "its offensive odor is permeating the building." And in 1934 it was deemed prudent to move the Observatory library to the main collection for better security.

This extended period of neglect beginning with the new Observatory in its third location was a reflection on the state of the University. The University had experienced a financial crisis during World War I, but had recovered somewhat in 1921. In the next legislative biennial, however, there was another reversal in finances. Although the decade of the 1920's was not a period of economic hardship in Missouri, the University was not well-supported in part because the administration did not press its case under the leadership of President Stratton D. Brooks and because of the failure of state government to support higher education. Thus, as Frank Stephens describes in his University history, the University entered a period of stagnation. President Brooks was relieved of duty in 1930, but by then the effects of the depression were being
felt by the state and in turn by the University. The worst year was 1933-34, after which economic conditions began to improve. In addition Middlebush had become President and he recognized the need to revitalize the University in all aspects. Haynes himself, however, recommended no more than continued maintenance of the present observatory and unlike his predecessors did not support any attempt to upgrade the facilities (see the accompanying letter from Haynes to Dean Curtis).

The Observatory incurred additional damages during its occupation by federal housing authorities after World War II. The post-war enrollment soared from about 5000 in the 1945 academic year to 11,452 in 1947/8. Former military barracks and other buildings were erected everywhere and overflowed into the golf links under an emergency housing program whose federal employees were allowed to use the Observatory for its offices. It became "impossible for the building or its equipment to be used for astronomical purposes," complained Haynes in a letter (27 August 1948) to Mr. Raymond Halbert, Superintendent of Buildings and Grounds. Under their occupancy, damage had occurred to the building, equipment had been removed and other items haphazardly moved about, and other damage had been sustained by the telescope and its drive due to unauthorized use. When the federal authorities left campus in 1950, the Observatory furniture disappeared with them. These people were then replaced by a nurse and a kindergarten for the children of the married students and janitorial supplies now occupied the basement. While the telescope rooms were to be kept locked, this was not the case and additional damages were occurring. Shortly before his retirement Haynes implored Dean Elmer Ellis to restore use of the Observatory to the Astronomy Department.

Thus during the era of Haynes the facilities of the Observatory were little used and some of the equipment was actually stored in Stewart Hall because of
the security problems at the golf course site. After Haynes' retirement, his successor Frank Edmonds, a member of the Department of Physics, and later Edmond's successor, Richard Levee, made some attempts to work with the Observatory. At this time (22 February 1951, in a letter to T.W. Fecker, Inc.) the 5 inch extra-focal camera still existed and Edmonds explored the possibility of its use for in-focus photography. He also explored the possibility of obtaining a used dome, but an advertisement in *Sky and Telescope* yielded no response except an offer of a used telescope. Fecker, Inc., would supply a new dome, but the cost of $9000 to $12000 was beyond the willingness of the University to provide funds, as was a later $1732.20 repair estimate to the old dome that Raymond Halbert, now manager of the Physical Plant, provided in November of 1951. In any case Halbert recognized that the state of the 70 year old dome was such that it would be cheaper in the long run to get a new dome. The Crawford - Gans telescope also still existed and Edmonds was able to have a concrete pier constructed on the front lawn of the observatory so that it could be used.

When Richard Levee arrived in 1952 he inherited the maintenance problems. Fecker, Inc., had revised its dome estimates to between $25,000 and $30,000. Somewhat imaginatively, Levee began to consider use of a silo top for an observatory dome - a silo top would cost only $300 - $400, but with modification for a slit, a new track for the rotation, and other installation costs, the total again became the prohibitive sum of $3200.00.

The last record in the Laws Observatory Papers of any serious attempt at maintenance occurred in February 1954 when Levee with John Reed and Jack McComb of the Central Missouri Amateur Astronomers spent some effort at cleaning and painting the buildings and in repairing fixtures. Whatever later and no doubt unsuccessful efforts were made after Levee's departure are not recorded in
archival files, though some maintenance must have been done there from time to time. By the late 1950's the condition of the 7½ inch refractor had deteriorated to the point where the wooden tube was replaced with an aluminum tube. Ultimately by the middle 1960's the Observatory site was wanted again for other University construction, this time a hospital.

The Department of Physics by now had inherited the Observatory, but its condition was now such that major repairs were necessary, yet funds for repairs were unavailable. As a result the Observatory was used little, but this lack of use itself provided an argument that the building was no longer required by the Department. Access to the Laws Observatory was given to various other University personnel and during this time a fair fraction of the remaining equipment and instruments disappeared. Shortly before its demolition in 1969 the 7½ inch telescope, the remaining transit instrument, and a few other records were salvaged.

The present Laws Observatory facility was opened in 1967 upon completion of the new Physics Building. The old telescope was placed in storage and three newer instruments purchased. All three were built by the Celestron Corporation in 1967 and are of the Schmidt-Cassegrain design. The largest, purchased at a cost of $9300, is housed in a standard observatory dome on the south side of the roof of the Physics Building. Two smaller telescopes of 10 inch aperture are mounted on concrete piers on the roof and are protected by removable wooden covers. All instruments are used for student instruction and for public viewing sessions on Friday nights during the school year.

Of the equipment that was once part of the older Laws Observatory, only the following items still exist on campus:
1. The 7½ inch Merz und Söhne telescope, now in storage in the basement of the Physics Building.
2. The clock constructed by Gregg and Rupp is now in the Physics Department library.

3. The clock built by Fauth and Company is in the faculty conference room of the Physics Building.

4. The sextant made by E. and G. W. Blunt of New York and three other sextants made by Pistor and Martin of Berlin (parts missing) are still in the possession of the Department. The Blunt instrument is nearly complete.

5. A filar micrometer, apparently originally used with the 7½ refractor, needs cleaning.

6. The transit instrument made by Brunner is missing the optics and other parts.

7. A surveyors transit made by Buff and Buff Manufacturing Company of Boston and another made by C.L. Berger and Sons, also of Boston, are in good repair.

8. The original Chronograph and one purchased at a later date are non-functional with a number of missing parts.

9. A theodolite made by the David White Company of Milwaukee, Wisconsin, exists and is in good repair.

10. The horizontal setting circle of the Blunt alt-azimuth instrument has been found, but there is no trace of the remainder of the instrument.

Some of the original equipment probably was scavenged for other uses in the physical laboratories, other parts went as scrap metal for the war effort in the 1940's, and the rest merely disappeared from an unsecured and neglected Observatory.
THE DEPARTMENT OF ASTRONOMY

Richard H. Jesse, president of the University 1891-1900, coming into office after the disturbances of the Laws administration set about to revitalize the University of Missouri. He was well prepared to do this for he had spent twelve successful years (1878-1890) at the University of Louisiana, essentially reestablishing that school which had been closed at the onset of the Civil War and overseeing its consolidation with the more recently founded Tulane University.

At the start of his administration, there were thirteen schools in the Academic Division of which six were sciences--Metaphysics, Mathematics, Physics, Chemistry, Geology and Mineralogy, and Biology. These "schools" became departments in 1892 and comprised a total of only 20 faculty--10 professors, 1 associate professor, 5 assistant professors, 1 instructor, and 3 assistants. In the following year Astronomy became an independent department under the charge of Professor Updegraff.

Jesse's administration began inauspiciously in Columbia with the destruction by fire in 1892 of the main academic building, but this allowed subsequent progress in construction of new buildings. Moreover during these first few years the last political maneuvering to remove the state university from Columbia was defeated, thus ending years of continuing conflict with the state legislature--the University finally was becoming a state rather than a local institution. In addition Jesse made substantial progress in building a reputable faculty, appointing persons of ability (including many with Ph.D.'s) and removing, where necessary, those of lesser standing; thus, the University moved a step closer to modern academic standards. Furthermore, the academic system underwent significant revisions including the inauguration of a graduate department in 1896 and development of degree requirements for Masters and
Doctoral awards (before these changes, a Masters Degree was given to any graduate who remained in his professional field for three years).

One of the faculty who served under President Jesse was Professor Milton Updegraff, who was appointed Assistant Professor of Mathematics of Astronomy and Director of Laws Observatory in 1890. In 1893 with the establishment of a Department of Astronomy he became Professor of Astronomy, but still held an Assistant Professorship in Mathematics. Updegraff can be considered to be the first true astronomer to have been at the University. Born in Iowa 20 February 1861, he studied at the University of Wisconsin, graduating with a B. S. and a Bachelor of Civil Engineering degree in 1884 and an M. S. in 1886. He served as Assistant Astronomer at Washburn Observatory under Professor Edward Holden who soon was to become director of the Lick Observatory. He continued his work on stellar positions as Astronomo Segundo at the Argentine National Observatory in Cordoba until his appointment to the faculty of the University of Missouri. After serving nine years, he was appointed by President McKinley to be Professor of Mathematics, U.S. Navy. (It is of interest to note that the aforementioned T. J. J. See received a similar appointment in the same year.)

The remainder of his career was spent mainly at the U.S. Naval Observatory in Washington, D. C. (meridian circle observations of the Fundamental Stars, later he was Director of the Nautical Almanac), or on the faculty of the U.S. Naval Academy in Annapolis, Maryland. He died on 12 September 1938.

Updegraff's time at the University of Missouri was occupied with teaching, maintenance of the instruments at the Observatory and with a limited amount of research. That there was a conflict between his judgement as to the division of time between academic duties and observatory research and the expectation of the University is not surprising. Updegraff's background was clearly oriented in one direction and the University in the other. Further not only were there the
frustrations of operating the Observatory with what Updegraff clearly considered to be inadequate facilities and inadequate funds to make corrections, but almost from the start he felt that his time and efforts in maintaining the observatory were not given the credit they were due.

With the University's emphasis on teaching one can understand that there would be in turn dissatisfaction with Updegraff's performance on the part of the University. In general, while his course hours were equivalent to others of the faculty, the number of students taught in astronomy was small. It is also notable too that during his tenure no student ever received the Laws Astronomical Medal, but this probably has more to do with the abolition in 1894 of the requirement that a Senior present a thesis prior to graduation.

The situation in 1898, in Updegraff's point of view, is revealed in a Report of the Laws Observatory and Department of Astronomy to the Board of Curators, dated 13 December 1891 (Laws Observatory Papers). This detailed report was motivated by a letter from President Jesse concerning "dissatisfaction on the part of the Board of Curators because the number of students taking Astronomy was not larger." The contrary was actually true, according to Updegraff; a greater number of students were enrolled and the "amount and character of the work being done was larger and better than ever before." To back up this contention, he summarized the student enrollment as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Astronomy Students*</th>
<th>Total Students in University</th>
<th>Percent in Astronomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1890-1</td>
<td>21</td>
<td>487</td>
<td>4</td>
</tr>
<tr>
<td>1891-2</td>
<td>22</td>
<td>631</td>
<td>3</td>
</tr>
<tr>
<td>1892-3</td>
<td>11</td>
<td>600</td>
<td>2</td>
</tr>
<tr>
<td>1893-4</td>
<td>17</td>
<td>593</td>
<td>3</td>
</tr>
<tr>
<td>1894-5</td>
<td>6</td>
<td>519</td>
<td>1</td>
</tr>
<tr>
<td>1895-6</td>
<td>16</td>
<td>681</td>
<td>2</td>
</tr>
<tr>
<td>1896-7</td>
<td>17</td>
<td>701</td>
<td>2.5</td>
</tr>
<tr>
<td>1897-8</td>
<td>23</td>
<td>701</td>
<td>3</td>
</tr>
<tr>
<td>1898-9</td>
<td>38</td>
<td>573</td>
<td>6</td>
</tr>
</tbody>
</table>
54.

(*These numbers appear to be an average of the enrollment in the two semesters each academic year, but do not completely agree with the semester enrollment reports preserved in the President's Office Papers. If anything Updegraff understated his case.) And he further compared the Missouri enrollment with that of other midwestern universities for the year 1896-7, the latest year for which he had complete enrollment figures:

<table>
<thead>
<tr>
<th>University</th>
<th>Total enrollment</th>
<th>Astronomy enrollment</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota</td>
<td>2470</td>
<td>46</td>
<td>2</td>
</tr>
<tr>
<td>Nebraska</td>
<td>1500</td>
<td>38</td>
<td>2.5</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1650</td>
<td>32</td>
<td>2</td>
</tr>
<tr>
<td>Michigan</td>
<td>3500</td>
<td>88</td>
<td>2.5</td>
</tr>
<tr>
<td>Missouri</td>
<td>701</td>
<td>17</td>
<td>2.5</td>
</tr>
<tr>
<td>Harvard</td>
<td>4000</td>
<td>67</td>
<td>2</td>
</tr>
</tbody>
</table>

On the basis of this comparison, the Astronomy enrollment at Missouri was not out of line. Furthermore, the "number of students in any subject depends largely on the number required to take it;" at Missouri the number of astronomy students agreed completely with the number of students in the Bachelor of Science program in the Academic Department who were required to take Astronomy. The rise in enrollment in 1897-8 and 1898-9 was the result of changes in the degree and elective requirements.

However, continued Updegraff, it had to be noted also that his duties were not limited to teaching Astronomy, but included additional instruction as Assistant Professor in the Department of Mathematics. To the total of 16 hours of teaching in both subjects must be added the routine observatory work which would be equivalent of 6 hours teaching, and an additional 3 hours per week in supervision of one graduate student in Astronomy. This effort was not comparable to the average number of 15 hours per week for other instructors in
The Astronomy curriculum as described in the University Catalogue for 1896/7 and 1897/8.

Astronomy.

Professor Upham.

1. Popular Astronomy. Lectures, recitations, and occasional night observations. Treatment non-mathematical. T. Th. S., at 11:30. (Kleective.)


2. General Astronomy. Lectures, recitations, and occasional night observations. M. W. F., at 11:30. (Sophomore and Junior.)


3a. Practical Astronomy (For Seniors in Civil Engineering). Recitations, and practical work in the Observatory. First semester, five hours a week.

   Text: Doolittle's Practical Astronomy.

3b. Goodey and Least Squares (For Seniors in Civil Engineering). Recitations, and practical work in the field. Second semester, four hours a week.

   Text: Sore's Geodesy.


   Calculus required. Text: Chauvenet's Spherical and Practical Astronomy.

5. Spherical and Practical Astronomy, Continuation of Course 4. Three hours a week. (Senior Kleective.)

6. Theoretical Astronomy. Theories of the undisturbed and disturbed motions of comets and planets. Three hours a week. (Graduate Kleective.)

   A thorough course in Calculus and Analytic Geometry is required.

   Text: Watson's Theoretical Astronomy.

   Required: For R. S., Course 2; for R. S. in C. E., Courses 5a and 5b.

The Laws Astronomical Medal:

An engraved medal, called the "S. S. Laws Astronomical Medal," is offered annually to that member of the graduating class who stands highest in Astronomy, and has at the same time attained a high average of general scholarship. An original thesis written on some astronomical subject, and showing capacity for scientific investigation, is required.

The Laws Observatory:

The Observatory, a building 51 feet long from east to west, and from 11 to 30 feet wide, stands on an elevated portion of the campus. The equipment consists of a 7½-inch equatorial refracting telescope by Merz and Söhne, of Munich, a 2 1-10-inch transit instrument by Brunner, of Paris, an altitude and azimuth instrument of 2½ inches in aperture, sidereal and mean-time clocks, sidereal break-circuit chronometer, chronograph, sextant, micrometer and a complete outfit of smaller instruments.

Clocks and instruments are mounted on piers of solid masonry, isolated from the floors and walls of the buildings, and are provided with the usual electrical connections. The dome of the telescope is 18 feet in diameter. A cone of 14 feet in diameter, which revolves on balls, shelters the altitude and azimuth instrument. The transit-room, which has three slits in the walls and roof for observation, contains the transit instruments, chronograph, and sidereal clock.

There is in the Observatory a valuable collection of astronomical books and pamphlets, and several of the best astronomical periodicals are regularly received.

In the year 1860, Dr. S. S. Laws, then President of the University, contributed largely from his private funds toward the improvement of the Observatory building and instruments. In recognition of his generosity the Board of Curators named the Observatory in his honor.
the University, but "Credit for the observatory work has hitherto been denied. I am simply stating the facts and am not at this time making any request or complaint."

With regard to the state of the Laws Observatory, Updegraff continued, the amount needed for repairs and to correct deficiencies in the Observatory equipment and books "is about the same as it was six years ago because very little has been done to improve our equipment within that time." And the situation was becoming poorer. In particular necessary subscriptions to astronomical periodicals which had expired the year before had yet to be renewed (at a cost of $35 per year) and there was the problem with the trees growing around the Observatory which interfered with the observations: "This trouble is growing worse every year." Nevertheless, after the necessary routine work and teaching duties had been completed, scientific work had been done "unassisted" and published when reduced. With the long standing dissatisfaction that is apparent in Updegraff's description, it is understandable that when the chance arose the following year to join the U.S. Naval Observatory, to pursue research in an atmosphere free of the burden of teaching and in the presence of assistants to handle routine chores, Updegraff would abandon the University of Missouri. It must also be pointed out that Updegraff could feel that the University situation held little prospect for improvement. The 1897-98 year was a difficulty one for the University and finances required both cuts in faculty salaries (already low by American university standards) and delay of expenditures for books and laboratory supplies.

When Updegraff left Columbia, there was no immediate replacement for him. The University Catalogue of 1899/1900 notes of Astronomy, that "this Chair is now vacant. The work in Astronomy (required for the major of Engineering) has been given by...the Professor of Mathematics." This would have been the same
John Nelson Fellows who seven years earlier as a student had received the Laws Astronomical Medal.

Updegraff was, however, soon replaced at the University of Missouri by Frederick H. Seares (1873-1964) who accepted the appointment to Professor of Astronomy and Director of Laws Observatory in 1901. Seares did not have a Ph.D. although he had spent four years at the University of California as a student and as an instructor and a year at the University of Paris and another at the University of Berlin. In later years both the University of California in 1930 and the University of Missouri in 1934 would award Seares honorary Doctorates of Laws.

Seares was a definite asset to the University of Missouri, for under his direction "the course in astronomy became an important scientific study." In an era in which research was not considered an important part of the duties of a professor, Seares built his reputation for research using the limited facilities of Laws Observatory.

A part of this success as compared to the more limited achievements of his predecessor must be due to personalities. Seares appears to have been more able to work within the system and to work with the facilities on hand. In turn, his more modest request for funds to improve and expand the Laws Observatory met with relatively greater success. And he was able to attract a small corps of able students and assistants to free him from much of the academic and other routine chores associated with the Astronomy program and with operation of the Observatory. But it is also true that Seares' tenure occurred during a significantly more favorable period, an era which, according to Stephens' History, would be long remembered as a Golden Age. The financial problems that occurred shortly before the resignation of Updegraff continued through 1900,
but in the following year and through the next decade there were significant improvements in state appropriations to the University, in part due to new taxes levied for the benefit of the University. Thus the administration could move to improve faculty salaries and support for academic and limited laboratory work. Accompanying this was an expansion of the student body which necessitated an expansion of campus facilities and faculty. More importantly, the development of graduate programs and initiation of student assistantships worked to alleviate the pressures on the time of the professors, which in the case of Astronomy, was a tremendous impetus for the accomplishment of research activities. His first work was positional observations of comets, soon followed by a photometric program on variable stars. The major portion of the results of this work was published in the Laws Observatory Bulletin which was initiated by Seares. Excerpts of his work were soon appearing in Astronomische Nachrichten, Popular Astronomy and the Publications of the Astronomical Society of the Pacific and regularly cited in the columns of the astronomical correspondents to Science and Nature. (This, in part, is an indication of the merit and outside interest in Seares' work, but probably also was due to some measure of self-promotion.) In 1906 he secured a grant of $500 from the Benjamin Apthorp Gould Fund of the National Academy of Sciences for work on photometry of variable stars and thus was able to employ Eli Stuart Haynes as an assistant with those funds. Haynes apparently had previously assisted from time to time in an unpaid capacity.

Seares also did not neglect other academic duties especially as the astronomical courses still played a required role in the curriculum for engineering degrees. Shortly before he left Columbia, he published a text book entitled Practical Astronomy for Engineers. This book was an outgrowth of his astronomy for engineers course and was written from his course notes. As he
The Benjamin Apthorp Gould Fund.—On Nov. 17, 1897, the sum of twenty thousand dollars was given to the National Academy of Sciences, as trustee, to establish a fund to be known as the Benjamin Apthorp Gould Fund, in memory of the father of the donor, Miss Alice Bache Gould, the income to be used to assist the prosecution of researches in astronomy, the administration of this income, in accordance with the terms of the trust and of a letter of instructions from the donor, to be under the direction of the undersigned.

A sufficient available income has now accrued from the Fund to warrant beginning its distribution, and the directors are prepared to receive and consider applications for appropriations. As a guide in framing such applications it is desirable to present briefly, but in close adherence to the exact terms of the trust and of the letter of instructions accompanying it, the principal provisions to be regarded in the administration of the Fund.

The objects of the institution are, first, to advance the science of astronomy; secondly, to honor the memory of Dr. Gould by ensuring that his power to accomplish scientific work shall not end with his death. In recognition of the fact that during Dr. Gould's lifetime his patriotic feeling and ambition to promote the progress of his chosen science were closely associated, it is preferred that the Fund should be used primarily for the benefit of investigators in his own country or of his own nationality. But it is further recognized both by the donor and the directors that sometimes the best possible service to American science is the maintenance of close communion between the scientific men of Europe and of America, and that therefore, even while acting in the spirit of the above restriction, it may occasionally be best to apply the money to the aid of a foreign investigator working abroad.

The wish was also expressed by the donor that in all cases work in the astronomy of precision should be given the preference over any work in astrophysics, both because of Dr. Gould's especial predilection and because of the present existence of generous endowments for astrophysics.

Finally, the Benjamin Apthorp Gould Fund is intended for the advancement and not for the diffusion of scientific knowledge, and is to be used to defray the actual expenses of investigation, rather than for the personal support of the investigator during the time of his researches, without absolutely excluding the latter use under the most exceptional circumstances.

Application for appropriations from the income of this Fund may be made informally by letter to any of the directors undersigned, stating the amount desired, the nature of the proposed investigation, and the manner in which the appropriation is to be expended. If favorably considered, a blank for formal application will be forwarded for signature, with the rules adopted by the directors for the administration of the Fund, and to which the applicant will be expected to subscribe.

LEWIS HOSS.
SETH C. CHANDLER,
ASAPH HALL.


An announcement of the establishment of the Benjamin Apthorp Gould Fund of the National Academy of Sciences which appeared in Popular Astronomy, 7, 168, 1899.
stated in the introduction, it was not a complete or a consistent work for it was written and printed by chapters, with the first chapters published before the last were written. Any deficiencies were intended to be corrected in a later revision (which was never published), but the book received favorable reviews (see, e.g., *Popular Astronomy*, 17, 459, 1909).

Seares also supervised courses in descriptive astronomy for non-science majors and over the years their enrollment grew significantly - a total of 264 students were enrolled in the 4 astronomy courses in the academic year 1908-09.

In addition to the students who were introduced to astronomy as part of distribution requirements for degrees in humanities and social sciences, credit must go to Seares for starting three students into productive careers in astronomy for it was Seares who initiated a formal degree in Astronomy at the University. These students were Harlow Shapley, later director of the Harvard College Observatory, Charles Clayton Wylie, later professor of astronomy at the University of Iowa, and Eli S. Haynes. Because Shapley would, from this start at the University of Missouri, go on to become "truly one of the great astronomers of all time" as well as a "leading spirit of the first half of the 20th century" (B. J. Bok, *Sky and Telescope*, 44, 354, 1972; Z. Kopel, *Astrophysics and Space Science*, 18, 258, 1972), additional biographical data are given in Appendix 7.

Shapley in his autobiography *Through Rugged Ways to the Stars* gives us some insight into University astronomy in the years 1906-1911. In 1908, in his third year at Columbia, Shapley became the assistant of Seares and thus was put in charge of the first year introductory course, "one of the snap courses for liberal arts students." In essence, although still a student, Shapley became a real member of the astronomy staff. As to research, he was able to observe a few variable stars although the photometer in use was a poor instrument, but, as
Shapley notes, for its time Laws Observatory was a complete observatory—still, "we got some of our education by finding faults in the instruments."

The assistance which Shapley and Haynes provided greatly lessened the academic burden on Seares, thus allowing him to spend more time on research efforts, especially in his last year when Haynes became an Instructor in Astronomy at a salary of $1000 per year. Shapley's employment as a student assistant was worth only $300 per year. The position was granted to the Astronomy Department upon Seares' request (1908) for a student assistant 1) to work as a stenographer to care for the "burdensome" Observatory correspondence, 2) to assist in the reduction of observations, and 3) to take care of miscellaneous duties such as winding clocks. Apparently teaching of the introductory astronomy came under the miscellaneous category, though no fair criticism could be leveled against Shapley's abilities in this matter.

As far as the course work which Shapley took, there really were but two astronomy courses. One was general astronomy and the other used the textbook in practical astronomy that Seares had written. For the most part, his education was not based on formal courses, but on private discussion with Seares who was a "good teacher." Clearly the requirements at the University of Missouri were much more flexible than under today's system. Shapley, the only astronomy major at the time, received his A.B. in 1910, and his M.A. a year later, during which time he was second to Haynes in the astronomy staff.

In 1909 Seares left Columbia to join the staff of the Mt. Wilson Observatory as Superintendent of the Computing Division. Later, in 1923, he became the Observatory's assistant director, a post he held until his retirement in 1940. His research during these later years was of great importance and earned him the Catherine Wolfe Bruce Gold Medal of the Astronomical Society of the Pacific in 1940 (See Appendix 6). In presenting this award to Seares,
The Astronomy curriculum as described in the University Catalogue for 1910/11. The courses follow essentially the same outline as under Frederick Seares. Shapley (Through Rugged Ways to the Stars) notes, however, that only two courses were formally taught with the others handled between the professor and the student on a very informal basis.

**ASTRONOMY.**

1a and 1b. Descriptive Astronomy. A general account of the methods and fundamental facts of astronomical science, together with an untechnical consideration of the problems upon which astronomers are engaged at the present time. Constellation study and demonstration exercises with the instruments of the Laws Observatory. (5). Mr. Haynes; Mr. Shapley.

2. Spherical and Practical Astronomy. (Prerequisite, Astronomy, 1a or 1b, Trigonometry, and General Physics). Lectures, recitations, and practical work with the instruments of the Laws Observatory. (3).

3. Spherical and Practical Astronomy. Prescribed for junior students in civil engineering. (2). Mr. Haynes; Mr. Shapley.

104. History of Astronomy. (Prerequisite, Astronomy 1a or 1b). Historical development of the science; its spirit; its influence on other sciences. The development of astronomical theories as an exemplification of the methods of science in general. (3).

105. Advanced Spherical and Practical Astronomy. (Prerequisite, Astronomy 2 or 3). (3).


107b. Method of Least Squares. (Prerequisite, Differential and Integral Calculus), with applications to the problems of astronomy and geodesy. (2). Mr. Haynes.

208. Theory of Orbits and Special Perturbations.


210. Research.

The Laws Observatory:

The practical work of the department of astronomy is carried on with the instruments of the Laws Observatory.

The equipment consists of a 7½-inch equatorial refracting telescope by Merz and Sons of Munich; a 4½-inch equatorial refracting telescope by Gans; a 2½-inch transit instrument by Brunner of Paris; a 2½-inch altitude and azimuth instrument by E. & G. W. Blunt of New York; a Zöllner-Müller photometer by Toepfer and Son; a Pickering stellar photometer; a disc photometer by Brashear; a theodolite; four engineers' transits; sidereal and meantime clocks; sidereal break-circuit chronometer; chronograph; sextants; micrometer; spectroscope; and outfit of smaller instruments.

Clocks and instruments are mounted on piers of solid masonry, isolated from the floors and walls of the buildings, and are provided with the usual electrical connections. The dome covering the 7½-inch telescope is 18 feet in diameter. A cone 14 feet in diameter shelters the 4½-inch equatorial.

In the year 1880, Dr. S. S. Laws, then President of the University, contributed largely from his private funds toward the improvement of the observatory building and instruments. In recognition of this generosity the Board of Curators named the observatory in his honor.

The Laws Astronomical Medal:

The "S. S. Laws Astronomical Medal" is offered annually at Commencement to the student who stands highest in astronomy, and has at the same time attained a high average of general scholarship. An original thesis written on some astronomical subject, and showing capacity for scientific investigation, is required.
A.S.P. President Alfred Joy wrote, "Dr. Seares' most important contributions to the science of astronomy pertain to the nature, brightness, and distribution of the stars. His investigations in these and allied subjects are fundamental, and in this field he is recognized as an outstanding authority. Many of the problems to which he has contributed largely have not yet reached their final solution, but his presentation of the salient features involved and his methods of attack will be invaluable to future investigators. His painstaking work in determining fundamental standards over the whole range of observable photographic magnitudes is recognized by photometric observers the world over as an achievement of the highest importance to astronomy."

At the University of Missouri, he was succeeded temporarily by Haynes. Haynes had enrolled at the University as a freshman in 1901, receiving his B. A. degree in 1905 and M. A. in mathematics in 1907. He had served as an assistant in the Mathematics Department in 1905 and 1906 and worked as a research assistant at Laws Observatory from 1906 to 1908. There he assisted Seares with the research and development of photometric techniques. With the departure of Seares, Haynes became an Instructor of Astronomy and de facto Chairman of the Astronomy Department until the arrival of Robert H. Baker who would serve in the same capacity as had Seares.

Robert Baker was from the East coast where he had obtained A.B. and A.M. degrees from Amherst College in 1904 and 1905, respectively. After receiving a Ph.D. in astronomy (1910) for work performed at the Allegheny Observatory of the University of Pittsburgh, he spent one year as Assistant Professor of Astronomy at Brown University before coming to the University of Missouri at a salary of $1800. Under Baker research continued at Laws Observatory, but at a lessened level than under Seares. As with Seares his major work was published in the Laws Observatory Bulletin. During the tenure of Baker the University
Catalogue also shows a diminution in the courses offered by the Astronomy Department and a description of the observatory, which had begun over 30 years earlier was dropped from the astronomy section. In 1923 Baker left the University of Missouri to go to the University of Illinois at which he would stay until his retirement. While at Illinois he wrote his famous textbook which became the standard introductory astronomical text for almost the next three decades.

Although Seares had been extremely productive and Baker carried on the work at the Laws Observatory, these years would become increasingly difficult for scientific work at the University. The presidency of Jesse ended with his growing health problems; in 1905 he was granted an extended leave of absence and in 1907 he tendered his resignation for reasons of health. Jesse was followed by President A. Ross Hill who apparently lacked the "same vision and vigor that Jesse had" (quoted from Gingrich).

According to Frank Stephens, the development of the modern administrative structure which had began under President Jesse continued under the administration of President Hill until 1914 when the period of the greatest development of the University ended. Apparently an able administrator on campus, Hill did not develop good relations with the state legislators, whose support by this era was so vital to the wellbeing of the University. Thus the illwill of political battles accumulated and was accentuated by the "caustic criticism" of other enemies. In 1915, state finances were bad due to adverse economic conditions. Preoccupied with the serious illness of his wife during the 1915 legislative session, Hill was unable to stem the budgetary cutbacks which brought the University close to financial disaster. The advent of World War I brought additional economic problems, with the cost of living doubling between 1915 and 1919, whereas the University in the same period granted salary increases of only
3.3%, far below what neighboring institutions were able to grant. As a consequence faculty began to drift away and they were not replaced. Other savings were achieved by encouraging faculty to take unpaid leaves to assist in the war effort. In 1920 and 1921 with state finances much improved, salaries could be increased by only about 20%; throughout the 1920's salaries remained low and were not competitive with other mid-western Universities, in spite of the fact that during this decade, the state economic condition was good. By 1929, a seven member commission appointed by the state government to survey the penal, charitable, and educational institutions of the state could conclude that the main problem with the University was the lack of adequate support from the state which could be traced to the states antiquated tax system. In this same era, President Hill would resign abruptly in 1921 and Stratton D. Brooks would assume the position. Brooks was forced to resign in 1930 after nearly ten years of weak administration and stagnation.

With the University in financial straits, budgetary restraints were passed on the departments by the administration. It appears too that some science faculty considered the science departments fared relatively worse due to attitudes of the University administrators. In 1921, Professor F. M. Tisdel of the English Department became Dean of the College of Arts and Science in which office he "devoted himself to the guidance and building up of the college, especially as the instrument of liberal education" (Viles). But according to Hammond, "the dean apparently had little comprehension of science nor sympathy for it. He seemed appalled at the cost of operating laboratories..." As a consequence there was pressure upon the scientific departments to reduce laboratory work. The work load on graduate students was increased to the detriment of their degree work. Furthermore, the strong emphasis on humanities and social sciences led to a revision of curriculum requirements which
effectively prevented completion of a B. S. program in four years; this was ultimately revised when strongly protested by the science departments, but the situation never was completely satisfactory.

In this context it thus can be seen that Robert Baker arrived to replace Frederick Seares at an excellent time and it is obvious that he was well aware of the potential opportunity. "All goes well here," he wrote to Frank Schlesinger of Allegheny Observatory shortly after his arrival (25 November 1911). "I am enjoying these surroundings hugely. There is a congenial spirit throughout the Faculty that I have not seen elsewhere. It seems much like one big family that meets often, not to get acquainted but because there is much in common." And in a letter (30 March 1912) to R.H. Curtiss of Detroit Observatory, Ann Arbor, Michigan: "Altogether things are going very well with us here. I find the University kindly disposed toward astronomy and liberal in the way of granting funds. The teaching part is rather heavy. I shall ask for assistance as soon as an observing program is under way. Students in astronomy this year will total about 175." Upon the suggestion of Curtiss, Baker had decided upon a program of photometry with an extra-focal camera whose purchase had been approved. And there was encouragement to begin considerations for improved observatory facilities. Charles Clayton Wylie was employed for two years as a student assistant and when he chose to pursue his Ph.D. work elsewhere, to relieve the teaching load on Baker, an Instructorship in Astronomy was granted in 1913.

Carl Clarence Kiess was hired in 1913, but apparently he and Baker did not get along with each other at the start. Later Baker would write to Frank Schlesinger (6 February 1915), that Kiess "is anxious to have more opportunity for research than the present situation affords." By now more aware of Kiess' abilities, Baker could provide a strong recommendation for his employment. "Kiess is industrious; he has a lot of ability for research and excellent
judgement to go with it. He has now had considerable experience as a teacher crowded into the short time he has been with us. He has done well with this."

Kiess' departure was a loss to Baker, for he was beginning to feel that teaching required too much time which could be spent for research. On 8 January 1915, he wrote again to Curtiss, "The new requirements in Civil Engineering will not include Astronomy, if I can help it, and in this event the teaching situation will be greatly improved."

Fortunately, before the budgetary disaster of the 1915 legislative session befell the University, Baker was able to have approved his request for an Assistantship in Astronomy for Miss Edith E. Cummings who would also write a Masters Thesis under Baker's direction. Two years later he recommended that she be advanced to Instructor in Astronomy and be allowed to work for a Ph.D., but this request was deleted due to "an unexpected and severe cut in the University appropriations." As a consequence Cummings left Missouri to continue her astronomical career.

In support of her application to study elsewhere, Baker wrote (from a letter to W. W. Campbell, Lick Observatory), "As an undergraduate Miss Cummings was the most promising student I have had... While unfortunately she is not a man, I believe she is handicapped by her sex less than any aspirant I have known. In our extrafocal work she has done a man's share, securing plates as well as measuring them. Her computing is rapid and accurate. She has unlimited enthusiasm and the necessary health and strength to accompany it. She intends to make astronomy her life work." She was accepted as a Fellow at Lick Observatory on 1 July 1918 and a year later filed as a candidate for the Ph.D. degree. At Lick she wrote a thesis on photometric work which was filed, although according to C.D. Shane in a letter (10 December 1980) to the author, there is no record that the degree actually was awarded. She married in 1921
and after a few years appears to have lost contact with astronomy.

With the heavy teaching load still adversely affecting the time available to do research and the growing possibility that University finances would long delay additional improvements to the Observatory, Baker began to think of other matters. In a letter to Schlesinger, 14 May 1917, he queried, "I wonder whether you are having text book troubles in connection with the teaching of descriptive astronomy. Young's splendid text book is so far out of date and Moulton's up-to-date book is so far from being a text book -- it is discouraging. I hereby threaten to write one." Schlesinger's reply was not encouraging. "I should advise you very strongly against writing any text book whatsoever under any circumstances within the next ten years at least." Spend your time on research, he advised and Baker heeded this council. His textbook was written a decade afterward and appeared in 1930. It is a credit to and an indication of his reputation that fifty years later the textbook still exists (9th edition) for collegiate use.

The next effect on Baker's career at the University was the result of the entry of the United States into the war. In 1918 Baker had arranged to spend a sabbatical year with Moulton at the University of Chicago. The department had been unable to find a replacement for Baker, due in part to the natural manpower shortage occasioned by the war effort and probably also to the relatively low salary that the University could offer, but Professor Reese and an assistant in the Department of Physics arranged to take Baker's courses. This was abruptly cancelled when "a naval unit descended upon us unexpectedly," he wrote to Schlesinger (31 January 1919), and he was forced to spend the year teaching them the principles of navigation.

In 1919, Baker understandably was becoming disenchanted with the continuing problems at Missouri. On 4 February 1919 he wrote to his friend
Curtiss, "Just now I am busy with plans for a new observatory. The matter has been brought up and tabled so many times that I have become quite discouraged, and I have now put it squarely up to the Curators that my connection with the University stands or falls with the success of the present attempt. The preliminary skirmish resulted in the approval of a new site and orders to the architect to draw up the plans. However, I have no illusion, only the conviction that it is absurd to have remained seven years in a place whose chief instrument is an obsolete telescope."

As if to add insult to injury, two years later Baker's request for a sabbatical leave for 1922-23 was turned down by the Board of Curators. In order to save money, sabbatical rules had been drastically altered in 1919. Baker appealed on grounds that his years at Missouri before the rules change had qualified him for paid leave. In his case the Board of Curators reconsidered and Baker spent the year at Lick Observatory on Mt. Hamilton, California. The University of California also awarded him the Martin Kellogg Fellowship which paid only $1200 for the year. In addition to accomplishing some research in collaboration with other Lick astronomers, Baker obviously spent his time seeking a position elsewhere. He returned to Columbia only briefly in August of 1923 before moving to Urbana, Illinois, where he had been appointed Professor of Astronomy at the University of Illinois. Without doubt, Baker may have wished that an earlier opportunity to leave Missouri has been successful. In spite of his initial happiness at Columbia, in 1912 a position at Detroit Observatory was offered to him. Writing to friend Curtiss, he said, "I am glad of the opportunity to come to Ann Arbor and hope there will be no great delay in my appointment." He had already by this time ordered the extra-focal camera for use at Laws Observatory, but a position at the established observatory was certainly to be preferred. "I hope my successor will carry out the program" at
Laws Observatory," and incidentally I wonder who it will be."

Upon his departure in 1923, he was replaced immediately by Professor Eli Stuart Haynes who would hold the chairmanship of the Astronomy Department until his retirement in 1950. Haynes had originally received his astronomical training here at the University of Missouri under Seares and had temporarily served as instructor in 1908-1911. In the fall of 1911 he had moved to California where he earned a doctorate in Astronomy at the University of California at Berkeley in 1913, after which he spent a year at Lick Observatory supported by a Martin Kellogg Fellowship. In 1914 he returned to the midwest where he taught astronomy at Beloit, Wisconsin, until taking the position in Columbia. The tenure of Haynes shows a strong contrast to the years of Seares and Baker, both of whom actively conducted research programs with the facilities of Laws Observatory. Except for his student years, Haynes essentially was not occupied with publication of the results of research. That this should be the case at Missouri is not surprising under the circumstances. Baker had left after years of frustration and after his departure financial conditions would not become conducive to support research, to acquire new equipment or even to make repairs at the Observatory, or to pay unlimited travel to scientific meetings. The years of stagnation in the 1920's were immediately followed by the Depression. To survive, the University cut salaries by 20%, reduced faculty through retirements, other attrition, and outright firings, curtailed the building program, ended support for purchase of laboratory supplies, and instituted fees and raised tuitions. The worst retrenchments were over by 1935 when Middlebush became President. As enrollments began to climb again, Middlebush began his efforts to revitalize the University. Salaries were improved and other efforts taken to improve faculty morale, building projects were resumed (supported by the federal Public Works Administration), etc. The
The Astronomy curriculum as revised by Professor Haynes (University Catalogue 1924/25).

ASTRONOMY

If, w, and sp. Descriptive Astronomy. An introduction to astronomy. (5) Mr. Baker.

3f. Practical Astronomy. Prerequisite, trigonometry. General principles of the subject. Practice in making and reducing observations with the transit instrument and the sextant. One laboratory period. (3) Mr. Baker.

10f and sp. Elementary Observations. Prerequisite, course 1. A study of the constellations and of the simpler celestial phenomena with and without the telescope. Laboratory course. (1) Mr. Baker.


102w. Modern Astronomy. Prerequisite, course 1. A descriptive course, chiefly in solar and sidereal astronomy. (2) Mr. Baker.


220f, w, and sp. Research. Credit to be arranged. Mr. Baker.

In case of demand, courses may be arranged in Celestial Mechanics, the Theory of Orbit Determination, or the Theory of Observational Errors.
year 1941 brought the entry of the United States into World War II and the University mobilized for the national effort.

It does seem to be the case, however, that Haynes at first did attempt to continue variable star work at the new Observatory. But the lack of funds for equipment, supplies, and assistance as well as the poor condition of the Observatory effectively combined to prevent any successful effort. Unassisted in his teaching, Haynes also became involved in time consuming administrative and committee work. Nevertheless, in response to a request (17 August 1929) by President Brooks for departmental 10-year plans, Haynes responded as follows: "The major objective of the department should be to institute (or rather to reinstitute) a modest program of research and publication and to increase its offering of graduate course (sic) suitable for election by majors in in (sic) the departments of Mathematics and Physics... it has been impossible to undertake research in astronomy here under the conditions which have obtained during the past few years." This plan, as outlined by Haynes, required additional personnel - at least an assistant professorship and a graduate assistantship, a research and publication fund and laboratory funds, major repairs to the observatory and a new equatorial telescope. Of these recommendations, a quarter-time graduate assistantship was approved for Richard M. Emberson at a salary of $300. The fate of the remaining items was sealed in 1931 by the Depression induced crisis. In a letter to all departmental chairman, Dean Tisdel wrote (16 October 1931), "I have today received a letter from the President asking for drastic reductions in the college of Arts and Sciences 'without reducing salaries and without impairing educational efficiency.'" Tisdel in his letter noted that there was no place in the astronomy allocation except to cut out Haynes' student assistant.

Ironically, it was in the time of this crisis that Haynes would become
involved in the only research effort of his 27-year professorship. As early as 1926 Haynes had recommended the name of Harlow Shapley to the Committee on Honorary Degrees. The degree was awarded in 1930 and as an outgrowth of the visit, Haynes entered into a variable star project as part of a cooperative venture of the Variable Star Committee of the International Astronomical Union aimed at redetermination of the Cepheid Period-Luminosity Relation. In this project Haynes worked with photographic materials supplied by Harvard College Observatory of which Shapley was Director. As part of the collaboration, Shapley invited Haynes to participate in the I.A.U. meeting at Harvard in the fall of 1932, a meeting which Haynes actually attended in one of his rare trips away from Columbia.

The second stimulus at this time was the fall of a bright meteor which was seen and heard over a wide geographic area on the 10th of August 1932. A few fragments were recovered near the small town of Archie, Missouri, 30 miles south of Kansas City. In the investigation of this object Haynes embarked on a lengthy process of questioning witnesses both in person and by letter (all without secretarial assistance).

With this work in hand, Haynes requested funds from Dean Tisdel for the publication of number 35 of the University of Missouri Observatory Bulletins, which would include the results of both the variable star and the Archie meteorite studies as well as an orbital calculation for Comet Peltier, 1933a. No funds were ever allocated by the College of Arts and Sciences and the Observatory publications quietly passed away forever. The meteorite paper was published eventually with the support of the American Meteoritic Society in the semi-popular journal Popular Astronomy. Although Shapley had indicated a willingness to put the variable star paper in the Harvard Observatory Bulletins, Haynes instead published a brief summary in the obscure Proceedings of the
Mr. Charles Graham,
News Department,
Kansas City Star,
Kansas City, Mo.

Dear Mr. Graham:

On my return from attendance on the meetings of the International Astronomical Union, I found your letter of August 22 in the mass of correspondence which had accumulated during my absence.

I sympathize with your determination to drop the study of astronomy. I frequently feel that way myself; but the subject has a fatal fascination for me. I have never been able really to reform and become a normal human being. I fear that I shall have to remain an astronomer to the end.

After reading over descriptions of the fall of the Archie meteorite as submitted by some hundred eyewitnesses, I feel particularly disgusted with meteorites. What did the damned thing have to hit in Missouri for? I need a staff of detectives, a few lawyers, and a jury to sift out the evidence contained in those letters. The testimony is so contradictory that I am not sure I shall ever be able to determine the direction from which that object really came.

The worst part of it is that I am now so burdened with university work that I am having to put off all consideration of the meteor problem for at least a week or two longer.

Well my next class is waiting, so I will have to quit for this time. I will let you know, if I ever succeed in making anything out of my meteor letters.

Very sincerely yours,

TH
Missouri Academy of Sciences in 1939. The Academy had been established only
four years earlier with Haynes as Chairman of Section D, Astronomy.

Aside from this research in the 1930's most of Haynes' efforts were
directed toward teaching. As a teacher he apparently was well regarded,
although no strong effort appears to have been made over the years to maintain
the astronomy enrollments. In the early 1920's enrollments were of the order of
150 students, a number which had been constant since the early 1900's when
Seares developed a strong teaching program. The most popular course was the
descriptive introductory course. A few mathematics and science majors
participated in the other courses, but Haynes stated that it had "never been the
policy of the department to give professional training" (University Missourian,
11 June 1924, pg. 4). By the time that Haynes retired, enrollments had declined
significantly to but a dozen or so students in the introductory class. The
reason for this was explained to the author one evening in 1980 during one of
the observatory's public open houses on Friday night. A university graduate of
about 1950 told me that "astronomy was just one of those courses you didn't take
- it was too mathematical" a comment that seems sadly all too familiar today.
Upon his retirement in 1950 Haynes was named Professor Emeritus.

At this same time Haynes played a role in the creation of the Central
Missouri Amateur Astronomers group which was organized in 1949. In 1950 he was
elected a member of the advisory council to the club. Before his death in
September 1956, Haynes would once again become Observatory Directory when no
astronomer was on the University faculty in 1954-1955.
Dear Dean Curtis:

In response to your request for a report on the present status of the Department of Astronomy and for suggestions relating to the proper organization and objectives of the Department in the post-war period, I desire to submit the following reply.

For many years the principal function of the Department of Astronomy in the University of Missouri has been that of instruction. The instructional program has had two phases of very unequal scope, as far as the number of students involved is concerned.

Certain courses have been offered with the purpose of providing, for students not prepared to undertake technical studies in the field, a summary of astronomical facts, doctrines, methods and conclusions with the purpose of widening their cultural horizons. The first course of this group has been accepted as satisfying the physical science requirement of the College of Arts and Science. Until last year the number of elections in this course varied from 120 to perhaps 50 students per year, with numbers gradually diminishing. In the present emergency the elections have been insufficient to justify giving the course.

The second group of courses offered have been concerned with the technical study of certain phases of the science of astronomy. The purposes of these courses have been: first, to acquaint mathematics and physics majors with the applications of their respective sciences in the field of astronomy; and, second, to provide background for students preparing as surveyors and navigators. The total elections in this second group of courses has seldom exceeded 10 or 12 per year.

The facts presented in the preceding statement together with the probability (perhaps I should say certainty) that in the post-war period accentuated emphasis will be laid on preparation for professional, business and industrial careers certainly requires careful consideration of policy on the part of the University with respect to instruction and research in a field which has such slight connection with the problem of earning a living.

As a preliminary to such consideration, I think that we should frankly assume that the system of group requirements under which the College of Arts and Science has so long operated will have to be scrapped or drastically reorganized. This system has served as a crutch to certain departments,
including the Department of Astronomy. The enrollment in astronomy courses whose primary objective is to broaden cultural horizons will not soon regain the pre-war level. In spite of this fact there will be in the post-war period, as always, a limited number of students whose intellectual curiosity about the universe should receive attention. The University should be prepared to take care of the needs of such students, even though their number be few.

The call for technical courses relating to the applications of mathematics and physics to astronomical problems will be renewed in the post-war period. This call should be met, because there is increasing need for specialization to be buttressed by understanding of allied fields.

In the post-war period there is sure to be much more extensive interest than formerly in meteorology, geography and navigation. A good understanding of certain phases of astronomy is needed as a background for the study of each of these subjects.

It is my considered opinion that instruction in astronomy will continue to be needed in the circumstances listed above. The number of students to be served is almost certain to be small. Other possible functions of the department should therefore be considered.

The University of Missouri has never attempted to prepare students for professional work in the field of astronomy. There should be no change in this policy. The number of professional astronomers and teachers of astronomy is few and their training is provided for by a few universities who preempted this field years ago.

The Observatory of the University of Missouri is practically useless from the standpoint of securing observational data on which to base any program of significant astronomical research. The University should never attempt to build and equip an observatory adequate for such purposes. My reasons for this statement are two. First, cost of such building and equipment is very great; and, second, the weather conditions here are very unfavorable for observing.

The fact remains, however, that astronomical research can be carried on at the University of Missouri. Nearly all astronomical observing is now done photographically. The study of the photographic record may be made anywhere. I am sure that it would be possible to arrange with one of the great research observatories a cooperative project in which the photographs needed for a specific piece of research could be made by a volunteer observer, perhaps during the summer, and then discussed later in his own office. It might also be possible to use plates already taken, discussed and stored and formulate a new project for them.

In the post-war period the Department of Astronomy should combine a program of instruction and a program of re-
search. No additional building space will be needed, but the Observatory should be restored to year-around operation to provide for office and laboratory space. Equipment would have to be purchased for work on the borrowed photographic plates. The nature and cost of such equipment would be determined by the type of project undertaken. The cost need not be very great.

The type of program which I have described could be carried out by one man with a student or office assistant. This man should have had teaching experience and recent experience in one of the principal research observatories, preferably the one with which the University of Missouri might seek to cooperate. The time is rapidly approaching when I must be retired. An interval of two or three years might be desirable in which to provide for the transfer of the department. At your convenience I shall be glad to discuss with you matters relating to the future of the department. Some items should be considered which I have preferred not to include in this letter.

Respectfully submitted,

Eli S. Haynes
The Astronomy curriculum shortly before the retirement of Professor Haynes (University Catalogue 1949/50).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Astronomy (5) f, w.</td>
<td>Prerequisite, one unit of algebra and one unit of plane geometry. A study of astronomical phenomena and of the solar system.</td>
</tr>
<tr>
<td>2</td>
<td>Introduction to Astronomy (3) w.</td>
<td>Prerequisite, a grade of M in course 1. Together with course 1 completes a survey of the field of astronomy.</td>
</tr>
<tr>
<td>3</td>
<td>Elementary Observing (1) f.</td>
<td>May be elected with or following course 1. Constellation study and simple observations with the instruments of the observatory.</td>
</tr>
<tr>
<td>12</td>
<td>Spherical Trigonometry (2) w.</td>
<td>Prerequisite, a grade of M in Mathematics 9 and 10.</td>
</tr>
<tr>
<td>204</td>
<td>Spherical Astronomy (3) f or w.</td>
<td>Prerequisite, differential calculus. A study of the theory underlying the standard processes in metrical astronomy.</td>
</tr>
<tr>
<td>205</td>
<td>Spherical Astronomy (2) w.</td>
<td>A continuation of course 204 covering such topics as the measurement of astronomical plates, binary star orbits, and elementary eclipse theory.</td>
</tr>
<tr>
<td>310</td>
<td>Celestial Mechanics (3) f or w.</td>
<td>Prerequisite, integral calculus and college physics.</td>
</tr>
<tr>
<td>350</td>
<td>Special Readings (2-3) w.</td>
<td>Prerequisites, courses 2 and 310.</td>
</tr>
<tr>
<td>411</td>
<td>Theory of Orbit Determination (3) f or w.</td>
<td>Prerequisite, course 310.</td>
</tr>
<tr>
<td>420</td>
<td>Second Course in Celestial Mechanics (3).</td>
<td>Prerequisites, courses 310 and 411.</td>
</tr>
</tbody>
</table>
The Astronomy curriculum as revised by Edmonds for the University year 1951-1952.

ASTRONOMY

1 Introduction to Astronomy (5) f, w.
Prerequisites, one unit of algebra and one unit of plane geometry. A survey of the field of astronomy emphasizing physical conditions of astronomical objects and subjects related to the structure of our galaxy.

2 Introduction to Astronomy (3) w.
Trigonometry must be taken prior to or concurrently with this course. A study of the solar system and problems of practical astronomy. Supplementary to but not a continuation of course 1.

310 Celestial Mechanics and the Solar System (3) w.
Prerequisites, graduate standing in mathematics or physics, or Physics 23 and 24 or equivalent and integral calculus. An introduction to celestial mechanics and a study of the solar system emphasizing applications of celestial mechanics.

311 Practical and Spherical Astronomy (3-4) f.
Prerequisites, graduate standing in mathematics or physics, or differential calculus and Physics 23 and 24 or equivalent. Astronomical instruments; determination of latitude, longitude and time; methods and problems in determining positions and motions on the celestial sphere; parallax; eclipses.

312 Astrophysics (3-4) f.
Prerequisites, graduate standing in physics or mathematics, or Physics 23 and 24 or equivalent and integral calculus. Stellar spectroscopy; photometry; stellar atmospheres and interiors; stellar energy; solar physics; variable stars; the physics of extended atmospheres, nebulae and interstellar matter.

313 Galactic Structure and Extra-Galactic Nebulae (3) w.
Prerequisites, graduate standing in physics or mathematics, or Physics 23 and 24 or equivalent and integral calculus. Stellar statistics and other techniques for determining the structure and internal motions of our galaxy; the properties of extra-galactic nebulae; cosmology and cosmogyony.

412 Radiative Transfer (3) w.
Prerequisites, differential equations, advanced calculus and a year of college physics. A study of diffuse transmission and reflection of radiation by gaseous atmospheres in accordance with the different physical laws for scattering.

413 Stellar Structure (2) f.
Prerequisites, differential equations and Physics 312 or equivalent. A study of stellar models emphasizing conditions for hydrostatic and radiative equilibrium, sources of energy production and stellar evolution.

414 Stellar Dynamics (2) f.
Prerequisites, differential equations and Physics 314 or equivalent. A study of stellar motions in clusters and galaxies using statistical methods of analysis in combination with principles of classical mechanics.
The retirement of Haynes is in a sense an end of an older era in Astronomy at the University of Missouri. This can be best illustrated by constrasting the Catalogue of courses offered under Haynes (1949/50) with the revised curriculum only two years later (Catalogue of 1951/2) offered by Haynes's successor, Frank N. Edmonds, Jr.--clearly a marked change from the more classical interests to those fields which are more in accord with the interests of the mainstream of modern astronomy. This is certainly a reflection on the differences between the two men who were schooled nearly four decades apart. As always we should note that a list of courses need not indicate that these courses were actually taught.

The retirement of Haynes also signaled the end of the Department of Astronomy as an independent entity within the School of Arts and Sciences at the University. The account as given by Gingrich in his history of the department of Physics is as follows: "I was told that in early years, classes in Astronomy were large (100 or more) but in the years before 1950, enrollment had dwindled to about 20 or 30. In 1950 Dean Ellis proposed dropping Astronomy as a Department and having one astronomer in Physics. I recommended strongly against this move but the action was nevertheless taken and I was asked to recruit an astronomer for our staff. Edmonds was the choice, but Astronomy classes did not suddenly increase in size. When Edmonds received an offer from Texas, Dean Ellis would not approve any incentive to keep him and he left." According to the University catalogue, Edmonds was an Assistant Professor of Astronomy, appointed in 1950 and at the University of Missouri for only two years. Apparently part of the reason for his departure had to do with a conflict between himself and the University administrators as to what part of his time was to be devoted to teaching and what part was devoted to research. But as
early as 14 December 1950, in a letter to W.A. Hiltner, then at Yerkes Observatory, Edmonds wrote that he was happy at Columbia, but, "My only regret is that administrative matters, mostly connected with my starting at the University, have taken up all time left from teaching and lecture preparations." That such a conflict could not be resolved is unfortunate for Edmonds is a capable person. He had received his A. B. from Princeton in 1941 and his Ph.D. in 1950 from the University of Chicago. He left Missouri for the University of Texas where he is now a full Professor in the Department of Astronomy on the Austin campus.

Edmonds was succeeded by Richard D. Levee who held A. B. (1948), M. A. and Ph. D. (1951) degrees from the University of California at Berkeley. After a year's stay in Princeton as a Research Assistant, he came to the University of Missouri as an Assistant Professor of Astronomy. After leaving Missouri he returned to California to spend a year in Berkeley as Resident Astronomer with the Leuschner Observatory, this followed by a staff position as physicist with the Lawrence Radiation Laboratory. He then seems to have left academia for an industrial position with the Control Data Corporation and now is Executive Vice-President of Culler-Harrison, Inc., in Goleta, California. Levee, after leaving Missouri, played a significant role in the development with Louis Henyey of the University of California-Berkeley of the computer algorithms which allow the numerical computation of the astrophysical equations for the calculation of the internal structure and evolution of stars. While apparently a capable and productive researcher, his capabilities and attitudes toward teaching at the University of Missouri were not satisfactory. Again to quote from Gingrich: "To increase enrollment in Elementary Astronomy, he tried to popularize astronomy by means of a number of innovations including having the class sing songs. Enrollment did increase significantly and it was said that word was
spread among students who belonged to sororities and fraternities that this was a kind of fun-course. Without notifying anyone, he arranged to have his lectures given either by pre-recorded tapes or by an undergraduate student for two or three weeks both before and after the long Christmas vacation. When he returned, he said he was working on a highly classified assignment that he could not discuss, even to say where it was. Eventually we learned it was at the laboratory where calculations were made for the hydrogen bomb. Dean Ellis learned about this and was displeased with the way Levee arranged for the Astronomy course. Levee was advised that his arrangement did not meet with University approval. Nevertheless, Levee felt obliged to do the same thing in his second year. Dean Ellis then asked him for details of his departure from duties and the salary he earned on that job. We were not advised what went on between Levee and the Dean, and eventually we were told that work in astronomy was cancelled so that no one would be needed in that area. Our strenuous objections to this were to no avail so that for 1954-55 there was no astronomy. Even newspaper editorials decried this situation of no astronomy at their State University and it was reinstated the following year." Publically, "Astronomy, one of the oldest courses at the University, was temporarily halted because of financial reasons." (University Missourian, 28 October 1954, pg. 7). It probably escaped the notice of the University administrators that 1954 marked the centennial of astronomy on the UM-C campus.

In all fairness to Levee, who might be considered as a free spirit in an era and a place when such was not socially acceptable, it must be pointed out that the long absences to do work at the Lawrence Radiation Laboratory actually were approved in advance by Dean Ellis subject to the condition that proper arrangements were made for the astronomy classes. Copies of the correspondence between Levee and Ellis exist in the Laws Observatory Papers. That some sort of
The Astronomy curriculum according to the University Catalogue of 1954/5 (Levee).

ASTRONOMY

1 Introduction to Astronomy (5) f, w.
   Prerequisites: one unit of algebra and one unit of plane geometry. A survey of research methods used in astronomy; a description of the astronomical universe emphasizing physical conditions; study of problems related to the structure of our galaxy.

310 Celestial Mechanics and the Solar System (3) w.
   Prerequisites: graduate standing in mathematics or physics, or Physics 23 and 24 (or equivalent) and integral calculus. An introduction to celestial mechanics and a study of the solar system emphasizing applications of celestial mechanics.

318 Numerical Analysis (3) f, w.
   Prerequisite, Calculus 201 or equivalent. Numerical solution of physical problems with emphasis on those involving differential equations and systems of differential equations; solution by hand computation, analog computers and electronic computers; interpolation, integration, differentiation, difference schemes, curve fitting.

The Astronomy curriculum according to the University Catalogue of 1961/2 (Schopp).

ASTRONOMY

1 Introduction to Astronomy (5) f, w.
   Prerequisite: elementary knowledge of algebra, plane geometry. Survey of research methods used in astronomy; description of solar system; stellar astronomy with emphasis on physical conditions; structure of galaxy and universe. SCHOPP.

210 Advanced Astronomy (3).
   Prerequisites: Astronomy 1 with grade of A or B, Mathematics 10 or equivalent. Detailed and quantitative examination of such topics as: Planetary and stellar motions, physical processes in stars, stellar systems and inter-stellar medium, cosmology. SCHOPP.

300 Problems (Credit to be arranged) f, w, s.
   Prerequisite: consent of instructor. Special studies in astronomy; covers subjects not included in courses regularly offered. SCHOPP.

330 Stellar Interiors (3).
   Prerequisites: 1 year of college physics, Mathematics 201. Review of basic astrophysical data, physical structure of stable stars, energy transport mechanisms, thermonuclear energy generation processes, stellar evolution. SCHOPP.
rapport was achieved between Levee and the undergraduates is shown by the phenomenal increase of enrollment from 60 students in the fall semester to 160 in the winter semester of 1954. Nevertheless, Levee that second semester found it necessary to bring the names of fourteen students to the attention of the Dean for being involved in a cheating incident. Levee suggested that any punishment be light as the problem in part was the result of "fraternity and sorority pressures."

After a years hiatus, John D. Schopp was hired in 1955 to teach the astronomy courses. Schopp had received his B. S. in 1949 from Northwestern University and a Ph.D. in Astronomy from Princeton University in 1954. He spent a year as a post-doctoral assistant at Northwestern before taking the faculty appointment in Columbia. When he left the University of Missouri in 1962, he went to the California State University-San Diego, and there he has participated in the development of that department into a substantial undergraduate department. According to Gingrich, "After his first two years here, John developed an excellent program in Elementary Astronomy attracting many students by the quality of his teaching. However, he never undertook research and for lack of such activity, the administration refused to give him a tenure appointment. The Department (of Physics) recommended him highly as a teacher but this was not considered sufficient by the administration."

Schopp was followed by two temporary appointments. William T. Hughes, then holding only an M.A. degree, taught astronomy in 1962. Five years later he completed work for his Ph.D. at Northwestern University during which time he held an Assistant Professorship at West Virginia State College. He later joined the Physics and Astronomy Department at Bowdoin College, Maine, where he now is a full Professor. "His teaching astronomy at Missouri was entirely satisfactory but he understood that his was a temporary appointment" (Gingrich).
Willett I. Beavers also only held a Masters degree while he taught astronomy at UM for two years, 1963-1965. He held a Bachelors and a Masters Degree from UM, obtained in 1955 and 1959, respectively. A year after leaving UM he received his Ph.D. from the University of Indiana. He had left UM to go to the University of Iowa as an Assistant Professor and since has been promoted to Associate Professor. He seems to have carried out a credible program at Iowa's Erwin W. Fick Observatory in developing its facilities and carrying out a research program on the measurement of stellar diameters.

Following the departure of Beavers the Department of Physics achieved its goal of having two astronomers on the faculty. The years of the 1960's were successful in building a larger Physics faculty and the problems of one astronomer on the staff had been well recognized. Astronomy is a discipline of its own, with attitudes and an approach to scientific research that are quite different from Physics; hence, a lone astronomer in a Physics Department can be effectively isolated from his colleagues by sole virtue of his training and research interests. Alan W. Peterson arrived in 1965 as an Assistant Professor, but stayed only two years. He held an A.B. 1951 from the University of California and an M.S. and Ph.D. (1957, and 1960, respectively) from the University of New Mexico. Prior to joining the UM staff, he had held a Research Associateship at the University of New Mexico and a position as Physicist with the General Dynamics Corporation. When he left UM he returned to the University of New Mexico as Associate Professor of Astronomy and later full Professor. His interests were oriented around non-stellar and planetary astronomical problems, including photometry of the zodiacal light, thermal emission from inter-planetary dust, and infrared studies. "He actively pursued research in the short time he was at Missouri and we lost a capable research man who improved his situation by returning to New Mexico" (Gingrich).
The Astronomy curriculum from the University Catalogue, 1966/7 (Peterson).

ASTRONOMY

1 Introduction to Astronomy (5) f, w.
Prerequisite: elementary knowledge of algebra & plane geometry. Survey of research methods used in astronomy; description of solar system; stellar astronomy with emphasis on physical condition; structure of galaxy and universe. No laboratory.

210 Advanced Astronomy (3).
Prerequisites: 1 with grade of A or B & Math. 10 or equiv. Detailed and quantitative examination of such topics as: Planetary and stellar motions, physical processes in stars, stellar system and inter-stellar medium, cosmology.

220 Space Physics (3) (Same as Physics 220)
Prerequisite: General Physics and a working knowledge of calculus. Review of solar system astronomy. Detailed study of solar electromagnetic and particulate radiation; solar flares and flare radiation; geomagnetic effects; solar, planetary and interplanetary magnetic fields; the near-earth space environment.

300 Problems (cr. arr.) f, w, s.
Prerequisite: consent of instr. Special studies in astronomy; covers subjects not included in courses regularly offered.

330 Stellar Interiors (3). (Same as Physics 330).
Prerequisites: 1 year col. physics & Math. 201. Review basic astrophysical data, physical structure of stable stars, energy transport mechanisms, thermonuclear energy generation processes, stellar evolution.

The Astronomy curriculum from the University Catalogue, 1972/3 (Edwards and Barnes).

ASTRONOMY

1 INTRODUCTION TO ASTRONOMY (5). Survey of research methods used in astronomy; description of solar system; stellar astronomy with emphasis on physical condition; structure of galaxy and universe. No laboratory. Prerequisite: elementary knowledge of algebra & plane geometry.

2 INTRODUCTION TO EXPERIMENTAL ASTRONOMY (5). Emphasis on observational and practical astronomy including telescope experience. Students will be selected from Astronomy I enrollees. Lectures common with Astronomy I satisfies physical science laboratory requirements. Prerequisite: elementary knowledge of algebra and plane geometry.

201 INTRODUCTION TO MODERN ASTRONOMY (5) (same as Physics 201). Elements of solar system, stellar, and galactic astrophysics. Emphasis on interpretation of observations and physical conditions of various astronomical objects including planets, stars, gaseous nebulae, and galaxies. Prerequisite: calculus or concurrent enrollment.

202 ASTRONOMICAL OBSERVATIONS AND MEASUREMENTS (2) (same as Physics 202). Elements of modern astronomical instruments, observations and analysis. Prerequisite: 201 or concurrently.

220 SPACE PHYSICS (3) (same as Physics 220). Review of solar system astronomy. Detailed study of solar electromagnetic and particulate radiations; geomagnetic effects; solar, planetary and interplanetary magnetic fields; the near-earth space environment. Prerequisite: 1 year college physics & a working knowledge of calculus.

300 PROBLEMS (cr. arr.) Special studies in astronomy; covers subjects not included in courses regularly offered. Prerequisite: consent of instructor.
The second astronomer to come at this time was Terry W. Edwards, who delayed his arrival until February of 1966 so as to complete his thesis work at the University of Wisconsin. His Ph.D. in Astronomy was awarded in 1968 following B. S. and M. S. degrees from the same institution in 1958 and 1961, respectively. Since coming to UM-C he has been involved in theoretical research programs concerning binary and variable stars and various aspects of the internal structure of stars. Concurrently he developed a substantial curriculum of astronomy courses and has supervised the Masters and Doctoral theses of several students.

To replace Peterson, Ronnie C. Barnes joined the Physics faculty on the Columbia Campus in 1968 originally as an Instructor of Astronomy. He was promoted to Assistant Professor upon completion of his Ph.D. from the University of Indiana in 1968. He also holds an A.M. degree, 1966, from the same institution and had done his undergraduate work at Vanderbilt University where he received a B.A. in 1963. Barnes' main efforts at Columbia concerned the undergraduate teaching program and only toward the last year or two of his stay did he attempt to publish, using work from his earlier Ph.D. Thesis. His lack of research work was the main reason that he was not extended a tenured appointment and he left in 1975 to take a position at Lambuth College in Jackson, Tennessee.

Early in their UM-C careers, Edwards and Barnes took part in an effort to further augment astronomy at the University of Missouri, the Mid-Continent Observatory discussions of 1968-1969, which, moreover, was an interesting example of an attempt to increase the level of astronomical activity throughout the whole mid-west region. The era in which a lone astronomer with a small telescope could constitute a productive research observatory had long since passed. The leading astronomical research institutions and astronomy depart-
ments in colleges and universities had grown to consist of multifaceted faculties of ten to twenty or more members, each relatively specialized, but with interaction among such large groups clearly being advantageous to individual and group productivity. The lone astronomer or group of two or three astronomers even if part of a larger Physics department was then, and is even more so now as this is written, at a strong disadvantage. Without question the astronomy at UM-C over the previous 20 (if not 60!) years shows the effect of this isolation. Although support for a moderate size observatory facility was not possible within the budgetary constraints of a single mid-western institution, an attempt to obtain university support and ultimately state and Federal support from a consortium effort was a possibility which showed sufficient promise of success to be actively persued.

In a sense there was a precedent for this effort, for in 1958 a consortium of seven institutions (now grown to fifteen members in 1980)--the Association of Universities for Research in Astronomy, Incorporated, or AURA, Inc.--had been formed to operate, under contract with the National Science Foundation, two national observatories. These facilities were not restricted to faculties of the member institutions, but were open for work by all astronomers in the United States. In addition to the national astronomical observatories, Kitt Peak National Observatory near Tucson, Arizona, and Cerro Tololo Inter-American Observatory, near La Serena, Chile, similar institutions operated by consortia existed for the benefit of radio astronomers (the National Radio-Astronomy Observatory operated by Associated Universities Inc. and the Arecibo Observatory of the National Astronomy and Ionosphere Center) and for other groups of scientists (e.g. Brookhaven, also operated by AUI under contract to NSF). In the 1960's several other groups also became interested in establishing observatories to be jointly operated for the benefit of their astronomical
faculties--these included discussions taking place between the Universities of Washington and Wisconsin, a group of Rocky Mountain area schools, and others.

The Mid-Continent Observatory was originally proposed by astronomer Richard Fowler of the University of Oklahoma and a working group had grown to five schools (The Five University Program) including Kansas State University, the University of Kansas, the University of Arkansas, and Wichita State University, when the University of Missouri was invited to join the discussions (Physics Chairman Holroyd and Professors Edwards and Barnes would take part). At one time or another representatives of Oklahoma State University and the University of Nebraska also would attend meetings.

At the beginning Harvard University had expressed willingness to assist in the development of the Mid-Continent Observatory astronomy and astrophysics program, with its participation to be phased out over a twenty year period. By this decade, however, the astronomical position of Harvard College Observatory had declined far below its eminence of earlier years; later discussions would consider both the University of Michigan and the University of Chicago as possible senior consultant/partners in the proposed observatory, as well as a possible working agreement for a facility at Kitt Peak National Observatory.

The objective was to secure an intermediate size telescope of the two meter class which, due to political expediency, probably would have to be located somewhere in the geographical region covered by the participating schools. Financing would come first from University sources, and later special legislative grants from the states and from Federal assistance. A copy of a "Skeleton Proposal", next page, best documents the direction towards which the proposal aimed.

Discussions occurred on a number of occasions in 1968 and ultimately a proposal to obtain National Science Foundation funding for necessary site
AN EARLY OUTLINE FOR THE PROPOSED DEVELOPMENT OF THE MID-CONTINENT OBSERVATORY

SKELETON PROPOSAL

A group of neighboring State Universities in the Plains States, not less than five in number, nor more than seven, will join with a well-established astronomical group to propose to the National Science Foundation that a regional observatory be set up under their auspices to promote the astrosiences in this portion of the United States.

The Management of the observatory will be by a corporation or trust whose members derive equally from the subscribing universities. The situs of the corporation will be dictated by the site of the observatory.

It is assumed that the cost of site development can be obtained as a special contribution from the State which receives the benefit of site selection.

The cost of a building, a 90 inch telescope, and necessary accessories are estimated at $2,300,000 as of 1967. Allowing for inflation at three per cent per year, the cost could become $2,700,000 by 1973. Presuming that NSF will accept 60 percent of this expense, the individual university capital commitment based on five participating universities will be $220,000. On the earliest possible schedule, this funding would be needed at a rate of $73,000 per year from 1971-1973.

If more than five universities subscribe, an augmentation of facilities will be contemplated rather than a reduction of the above contribution.

A continuing expense will need to be met which will be charged to users in proportion to their assigned time. This will result in an annual charge to each participating state university of not less than $3,000 immediately after completion of the observatory and ranging potentially up to $6,000 in the course of about a decade.

In addition to the above costs, individual universities will need to allow for their own expenses for faculty, travel, special project supplies and equipment needed at the observatory, etc.

For its services in design and planning of our observatory and its assistance in improving our mutual programs in astronomy, and to ensure the full use of the facilities, the well-established university group which will be invited to join with us will be awarded 50 per cent of the available time initially, tapering to zero at a to-be-negotiated rate over a to-be-negotiated period of perhaps 10-20 years. Furthermore, they may receive any unused portions of other users assigned time.
surveys was submitted in May of 1969. One site to be tested was Black Mesa near Kenton, Oklahoma, although other sites including at the established observatories of Kitt Peak and McDonald and the Mt. Hopkins site under development by the Smithsonian Astrophysical Observatory were also considered.

The Mid-Continent Observatory essentially died when the site survey proposal was not funded by the National Science Foundation. The end of the 1960's was, however, a poor time to start even a moderately ambitious program that required a substantial part of its funding from the Federal government. A decade earlier the unexpected Soviet initiative into space had generated a "Space Race" on the part of the United States. A spectacular growth of Federal funding not only led ten years later to the success of the Apollo expeditions to the moon, but also to a great increase of scientific work in the Universities. But by the end of the 1960's, the growth era in funding was over. Between the cost of an undeclared war, inflation, and growing pressure to redirect Federal funds to social programs, money for scientific research and development was in a decline which still affects scientific work today. As died the Mid-Continent Observatory, so died other efforts such as that of the University of Washington and the University of Wisconsin. By no means, however, is it fair to say that all support of astronomy disappeared, for the Federal government via the National Science Foundation consistently has supported the KPNO and CTIO observatories under the auspices of AURA, Inc., and Federal monies have aided in developments where they were matched by substantial local funds (e.g. the University of Arizona consortium efforts with the Smithsonian Astrophysical Observatory on Mt. Hopkins, and the observatory construction of the University of Hawaii). The astronomical efforts at Mid-western universities remain small.

Barnes was replaced only after a year's interval when negotiations with Dr. James E. Hesser of Cerro Tololo Inter-American Observatory did not succeed in
attracting him to Missouri. Instead Hesser took a financially less favorable position with the Dominion Astrophysical Observatory in British Columbia in order to remain in a research institution. The open position was filled in 1976 when the author joined the University of Missouri staff. He holds a B.S. in Physics from the University of Washington (1963), and Masters and Doctoral degrees from the University of California at Berkeley (1968 and 1975, respectively). Before coming to Columbia, he held post-doctoral appointments at the Department of Terrestrial Magnetism, Carnegie Institution of Washington (1974-1976), and at Cerro Tololo Inter-American Observatory, La Serena, Chile (1976-1978). His interests are primarily oriented about observational studies of the structure and dynamics of galaxies, observational work which is accomplished with the facilities of the national observatories at Kitt Peak and at Cerro Tololo.
THE FUTURE OF ASTRONOMY AT THE UNIVERSITY OF MISSOURI-COLUMBIA

Astronomy received strong support in the curriculum of the University in the early years of the institution due to the interests of two individuals, William Wilson Hudson and later President Samuel Spahr Laws, and this was consistent with the importance of astronomy in the science of that era. The height of astronomical activities, both in teaching and in research, occurred under Professor Frederick H. Seares between 1901 and 1909 during which time his work and Laws Observatory received international recognition. With the development of a formal academic program in Astronomy, Haynes, Wylie, and Shapley were set forth on productive careers in Astronomy. Robert H. Baker continued in the tradition of Seares. Had an economic crisis not occurred, Baker might have succeeded in gaining University support for a new observatory with significantly improved facilities and a larger telescope, but such was not the case. After Baker left in 1923, the importance of astronomical research at the University of Missouri declined.

The University emphasis was on teaching, not research, and as a result the Laws Observatory facility was neglected. Over the years, too, other scientific departments had come into existence as scientific specialization grew and these competed for the limited available funds. Yet as astronomical work expanded our understanding of the Universe, research emphasis was placed on larger and larger telescopes which required ever greater levels of funds for more modern facilities; such funds were unavailable within Missouri.

In the 1950's the responsibility for maintenance of a curriculum in Astronomy passed to the Department of Physics which in recent years has supported two astronomers among their faculty. Even with this welcome support there is reason to argue for an expanded astronomical effort at the University of Missouri.
This is essentially the point that a limited number of faculty (two) cannot realistically hope to maintain even a modest astronomical effort either on its own merits or in competition with other institutions whose astronomical departments are adequately staffed to cover the myriads of specialities within the profession. Within the last decades have developed specialities of radio astronomy, infra-red astronomy, gamma-ray and X-ray (or high energy) astronomy, space physics, astrogeology, and other fields which closely tie together traditional astronomy with fields of modern physics. Many of the most significant scientific advances of recent years have occurred as an outgrowth of attempts to explain phenomena originally discovered by astronomers. To cite a few examples, gravitational physics has undergone a renaissance due to attempts to detect gravitational waves from cosmological sources; the detection of neutron stars has spurred efforts to understand the behavior of matter at high densities and temperatures; the existence of black holes has an important relation to study of physical conditions under relativistic conditions; the Solar neutrino problem may ultimately be solved only by a revision of ideas of elementary particle physics; and indeed, the present nature and dynamical behavior of the Universe as a whole in the present era is now recognized to depend on the properties of nuclei and elementary particles whose behavior dominated the first few seconds of the cosmic expansion. With the operation in 1984 of the Space Telescope will come new discoveries which will lead to further interaction between astronomers and physicists. In essence, the future of a major portion of physical science implies an evergrowing interaction between these two sciences.

The quality of the Physics program at the University of Missouri has grown significantly in the last few years. It is of substantial importance to the University that in the future the Department also keep pace with the everchanging developments of the astronomical world.
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APPENDIX 1

CHRONOLOGICAL SUMMARY

1843-1856 William Wilson Hudson; Professor of Mathematics, Natural Philosophy, and Astronomy

1853 First observatory completed

1856-1859 W. W. Hudson; President of the University and Professor of Natural Philosophy, Astronomy, and Engineering

1860-1862 Edward F. Fristoe; Professor of Mathematics and Astronomy

1865-1887 Joseph Ficklin; Professor of Mathematics, Astronomy, and Engineering and Director of the Observatory

1880 Observatory moved to its second location, named after President Samuel Spahr Laws; Laws Astronomical Medal

1887-1890 William A. Cauthorn, Assistant Professor of Mathematics, in charge of Laws Observatory (but see text)

1890-1899 Milton Updegraff; Professor of Mathematics and Astronomy and Director of Laws Observatory; after 1893, Professor of Astronomy and Assistant Professor of Mathematics

1893 Astronomy given separate departmental status

1899-1901 Professorship of Astronomy open; John Nelson Fellows, Professor of Mathematics, teaches astronomy courses

1901-1909 Frederick Hanley Seares; Professor of Astronomy and Director of Laws Observatory

1906-1911 Eli Stuart Haynes; research assistant at Laws Observatory (1906-1908), Instructor of Astronomy (1908-1911), and acting Director of Laws Observatory (1909-1911)

1908-1910 Harlow Shapley; Assistant in Astronomy

1911-1923 Robert Horace Baker; Assistant Professor (1911-1913), Associate Professor (1913-1914), and Professor of Astronomy (1914-1923) and Director of Laws Observatory (1911-1923)

1911-1913 Charles Clayton Wylie; Assistant in Astronomy

1913-1915 Carl Clarence Kiess; Instructor in Astronomy

1915-1917 Edith E. Cummings; Assistant at Laws Observatory

1919 Observatory moved to its third location (officially no longer the Laws Observatory)
1922-1923  Bancroft Walker Sitterly; Instructor in Astronomy
1923-1950  Eli Stuart Haynes; Professor of Astronomy and Director of the Missouri University Observatory
1950      Astronomy Department ceases to exist upon retirement of Haynes
1950-1952  Frank N. Edmonds; Assistant Professor of Astronomy (in the Physics Department)
1952-1954  Richard D. Levee; Assistant Professor of Astronomy (in the Physics Department)
1954-1955  Astronomy dropped from University curriculum; Professor Emeritus Haynes becomes acting Director of the Laws Observatory
1955-1962  John D. Schopp; Assistant Professor of Astronomy (in the Physics Department)
1962-1963  William T. Hughes; Instructor to teach astronomy
1963-1965  Willett I. Beavers; Instructor to teach astronomy
1965-1967  Alan W. Peterson; Assistant Professor of Physics and Astronomy
1967      Laws Observatory relocated to roof of Physics Building
1966-     Terry W. Edwards; Assistant Professor (1966-1971), and Associate Professor of Physics and Astronomy (1971- )
1968-1974  Ronnie C. Barnes; Instructor (1968-1969) and Assistant Professor of Physics and Astronomy (1969-1974)
1976-     Charles J. Peterson; Assistant Professor of Physics and Astronomy