# Bryson Zullig, Undecided

**University**:  Northwest Missouri State University
**Year in School**:  Sophomore
**Hometown**:  Carrollton, Missouri
**Faculty Mentor**:  Dr. Alan Whittington, Geological Sciences
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## Synthesis and characterization of amorphous astrominerals

*Bryson Zullig, Alan Whittington, and Angela Speck*

Asymptotic Giant Branch (AGB) stars are the main contributors of solid material (dust) to the interstellar medium. The dust forms as gas escaping from the star cools and condenses to form a circumstellar dust shell. Around oxygen-rich stars, most of the dust particles are silicates, but important questions remain about which minerals are formed and whether the grains are crystalline or amorphous (glassy). Dust grains that form below the glass transition temperature ($T_g$) of a particular mineral should be amorphous, while those that form much above $T_g$ should be crystalline. The most refractory silicates predicted to form are members of the Melilite group of minerals, whose end-members are Gehlenite ($Ca_2Al_2SiO_7$), Sodium Melilite ($CaNaAlSi_2O_7$) and Åkermanite ($Ca_2MgSiO_7$). Synthetic glasses corresponding to these end-member compositions were synthesized from oxide and carbonate powders by melting in Pt crucibles in a muffle furnace at temperatures up to 1650˚C. The viscosity of the melts was measured by the parallel-plate technique in the temperature range 655 to 900˚C, over the viscosity range $2 \times 10^7$ to $9 \times 10^{12}$ Pa s. The viscosity-temperature data were interpolated to determine $T_g$ for each glass, taken to be the temperature at which the viscosity is $10^{12}$ Pa s. Two naturally occurring mineral samples, of åkermanite and gehlenite, were also melted. At higher temperatures and lower viscosities than about $10^8$ Pa s, crystallization is expected to be rapid relative to the timescale of cooling in circumstellar dust shells. Our experimentally determined glass transition temperatures therefore provide constraints on the nature (crystalline vs amorphous) of several refractory astrominerals predicted to be found in these shells. Future studies of these glasses will include infrared spectroscopy, in order to better interpret astronomical spectra and test for the presence of amorphous dust with these compositions. The results will be used to test competing models for circumstellar dust formation.