PROBING EXTRAGALACTIC DUST THROUGH GAMMA-RAY BURST AFTERGLOWS

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ABSTRACT

Gamma-Ray Bursts (GRBs) are the most powerful explosions in the universe and a very interesting phenomenon in themselves. The gamma-rays and the X-ray flashes (XRFs) are the manifestations of the most violent, cataclysmic explosions in the Universe. GRBs are followed by so-called afterglow emission detected in lower energy bands and on longer timescales, e.g. X-ray, UV, optical, near-infrared, radio emissions from a few hundred seconds to a few months. The following thesis does not deal with the GRB phenomenon itself but it is studying their environment and host galaxies through optical spectroscopy and using them as light sources in the distant universe. This thesis is divided into six parts.

The first chapter of the thesis discusses the importance of dust on exploring the host galaxies of GRBs. In the second chapter, we present a detailed study on the obscuration and reddening by dust in GRB host galaxies. We propose a novel approach - “Drude” model to derive the GRB host extinction law. We also present the general dust extinction models and explain why our “Drude” model is more favourable. With the template extinction laws all self-contained, and the capability of revealing extinction laws differing from the conventional ones, it is shown that this is a powerful approach in modeling the afterglow SEDs to derive GRB host extinction. In the third chapter, we select GRB070802 at \( z = 2.45 \) (which shows clear evidence for the 2175Å extinction bump) and GRB050904 at \( z = 6.29 \), the 3rd most distant GRB observed to date and fit their afterglow spectra to determine the extinction of their host galaxies, with an emphasis on the 2175Å extinction feature at high redshifts. We find that their extinction curves differ substantially from that of the Milky Way, the Small and Large Magellanic Clouds, the 2175Å extinction feature appears to be also present in GRB050904 at \( z = 6.29 \). In the fourth and fifth chapter, we present a study of the dust properties for a large sample (33 objects) of long-GRB host galaxies at \( z < 2.0 \) and another large sample (27 objects) at \( z > 2.0 \), respectively. From the derived strength of the far-UV extinction rise, strength of the 2175Å extinction, the total-to-selective extinction ratio \( R_V \), host galaxy visual extinction \( A_V \), dust composition and the mass-weighted mean dust sizes of all 60 GRBs, we find no evidence of evolution of the dust properties (extinction, sizes and abundance) on redshifts. The thesis ends with summary, outlook and the references.