Ultraviolet Spectroscopy of a Super-Chandra Type Ia Supernova Candidate SN2016ccj

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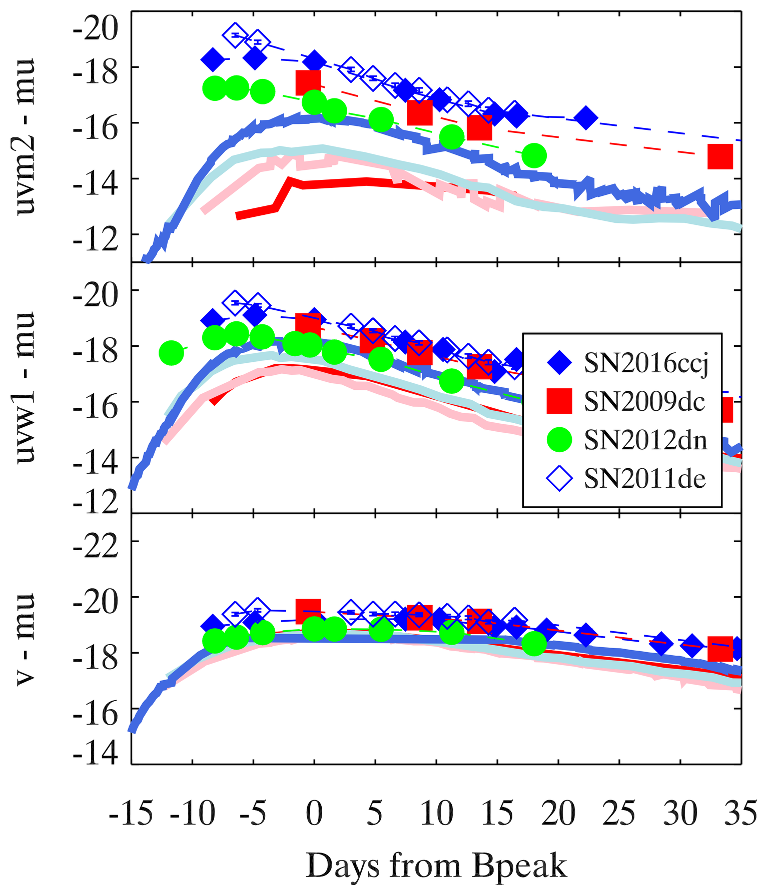
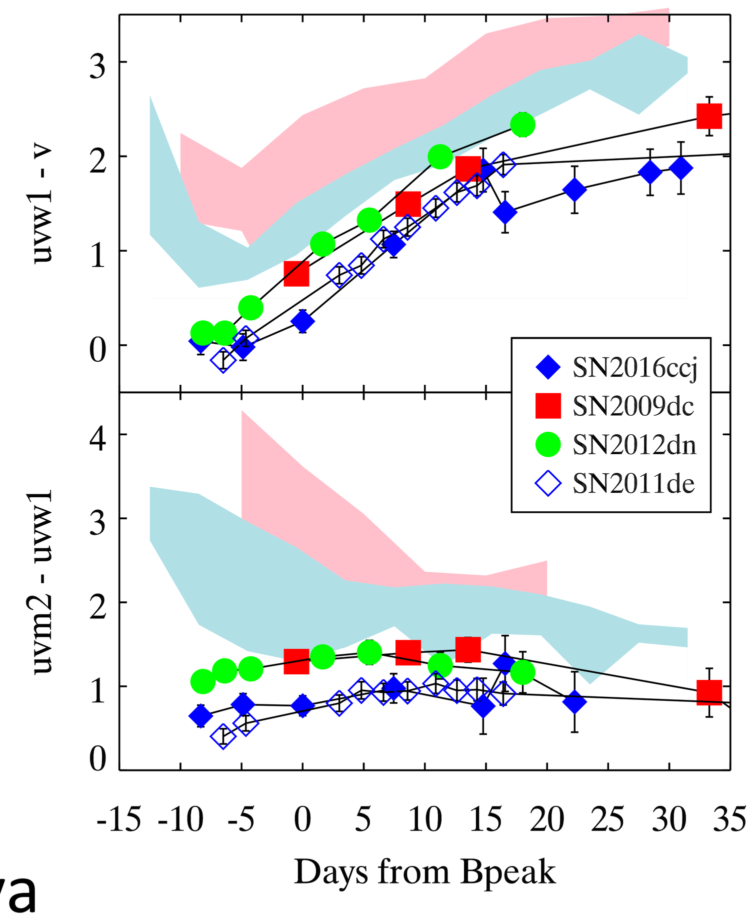
If the uniform luminosity of type Ia supernovae results from the thermonuclear explosion of a white dwarf reaching the Chandrasekhar limit, why are some type Ia supernovae overluminous with a derived ejecta mass greater than the Chandrasekhar limit?

Swift ultraviolet observations have shown these so-called Super-Chandra candidates to also be overluminous in the ultraviolet by a factor of more than ten (Brown et al. 2014).



My Hubble program targeted such a supernova for ultraviolet spectroscopy to understand the nature of the excess ultraviolet luminosity.



Just google "Swift Supernovae" or scan this QR code to reach the Swift supernova website with a supernova list, light curves, and available data from the Swift Optical Ultraviolet Supernova Archive (SOUSA).

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SN2016ccj was spectroscopically similar to so-called super-Chandrasekhar mass type Ia supernovae and identified as ultraviolet-bright and blue with prompt observations with the Swift Ultra-Violet Optical Telescope (UVOT). Hubble Space Telescope (HST) observations were triggered to obtain high-quality ultraviolet spectra. Three epochs were obtained, as shown to the right.

SN2016ccj was indeed much brighter in the ultraviolet than normal type Ia supernovae, in particular a flat plateau in the near ultraviolet.

One hypothesis is that the excess luminosity could come from interaction with the circumstellar medium or the donor companion star (Kasen 2010). The structured ultraviolet spectra observed with Swift/UVOT (Brown et al. 2014) and this HST program reject the contribution from a blackbody.

An alternative hypothesis is that a hotter photosphere shifts the ionization of the iron peak elements, shifting the absorption from the mid- and near-ultraviolet to the far-ultraviolet. However, the spectral features seen in the hotter iPTF14bdn (Smitka et al. 2015) are not seen in SN2016ccj.

The broad emission peak (which may just be an absorbed continuum) is similar to the ultraviolet-bright SN2004dt (Wang et al. 2012). SN2004dt, however, was a very different supernova with very broad absorption lines and the highest measured polariztion of any type Ia supernova.

The Swift UVOT filters are well placed to characterize the ultraviolet diversity for a growing sample of type Ia supernovae of all subtypes. There is great synergy with the Hubble Space Telescope, as we can identify the UV characteristics from prompt Swift observations and trigger Hubble for high-quality ultraviolet spectra.