

Swift Links Peculiar Subtypes and Bump Type Ia Supernovae

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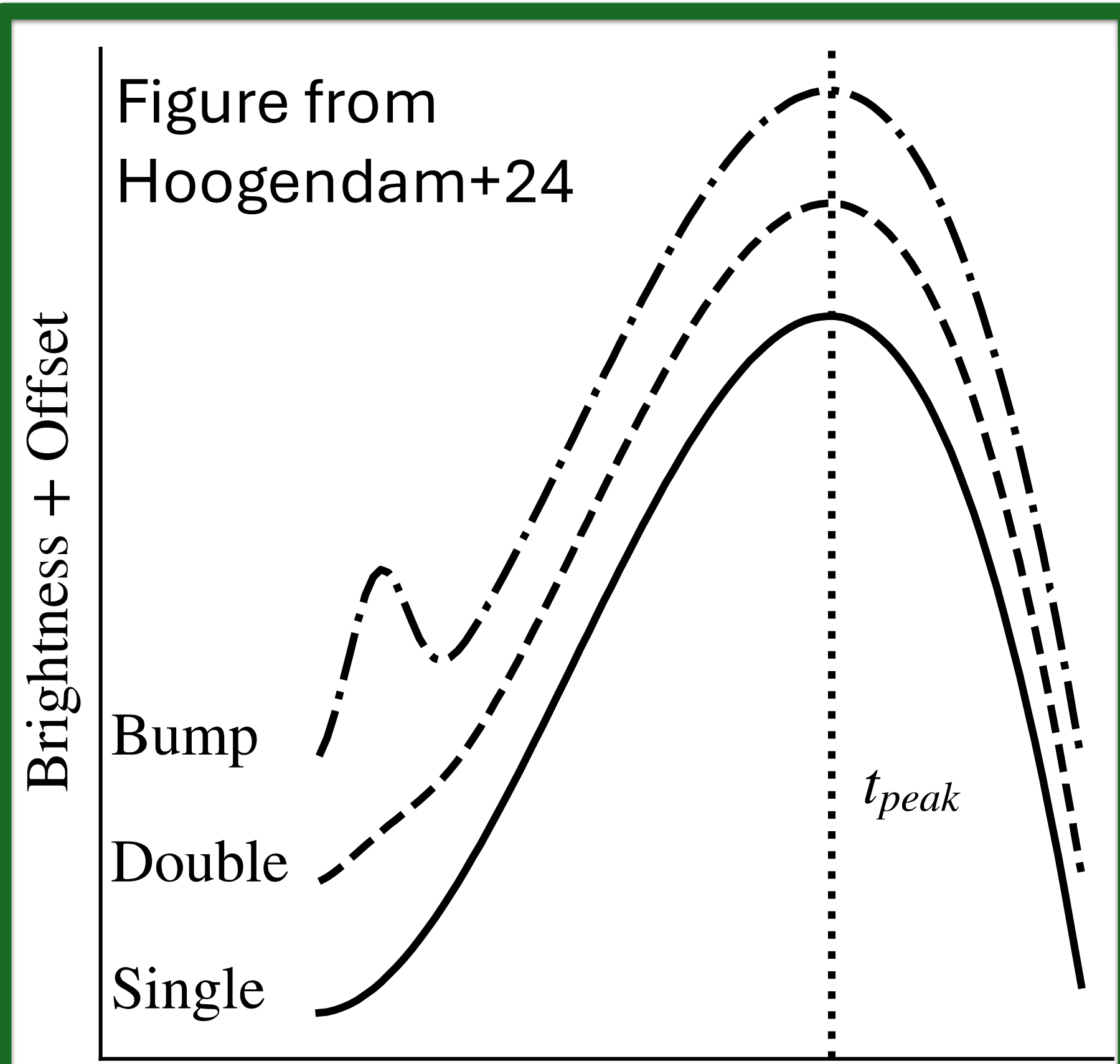


Figure from Hoogendam+24

Bump
Double
Single

Time

t_{peak}

Recent observations have found nonmonotonic rising light curve bumps in Type Ia Supernovae (SNe Ia). We propose a new observational heuristic: “bump” for non-monotonic rises, “double” or “excess” for additional, monotonic flux, and “single” for smoothly rising light curves. We explored the UV colors for each rising light curve category.

References

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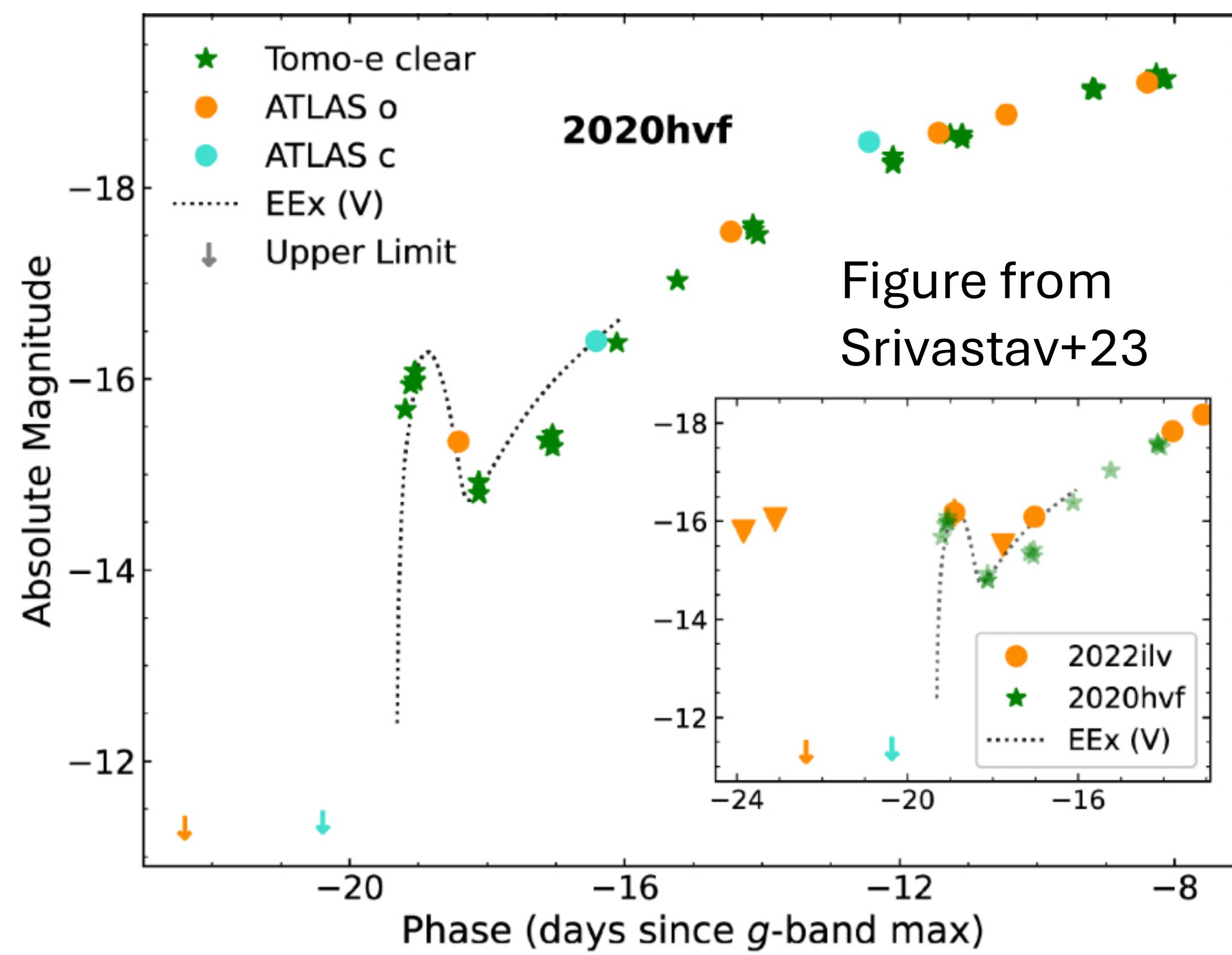


Figure from Srivastav+23

SNe 2020hvf and 2022ilv are examples of bump SNe Ia. They have non-monotonic rising light curves. This is in contrast to ASASSN-18bt, a “double” SN Ia with a two-component power-law rise. Most SNe Ia, including SN 2011fe, rise with a smooth, single power law.

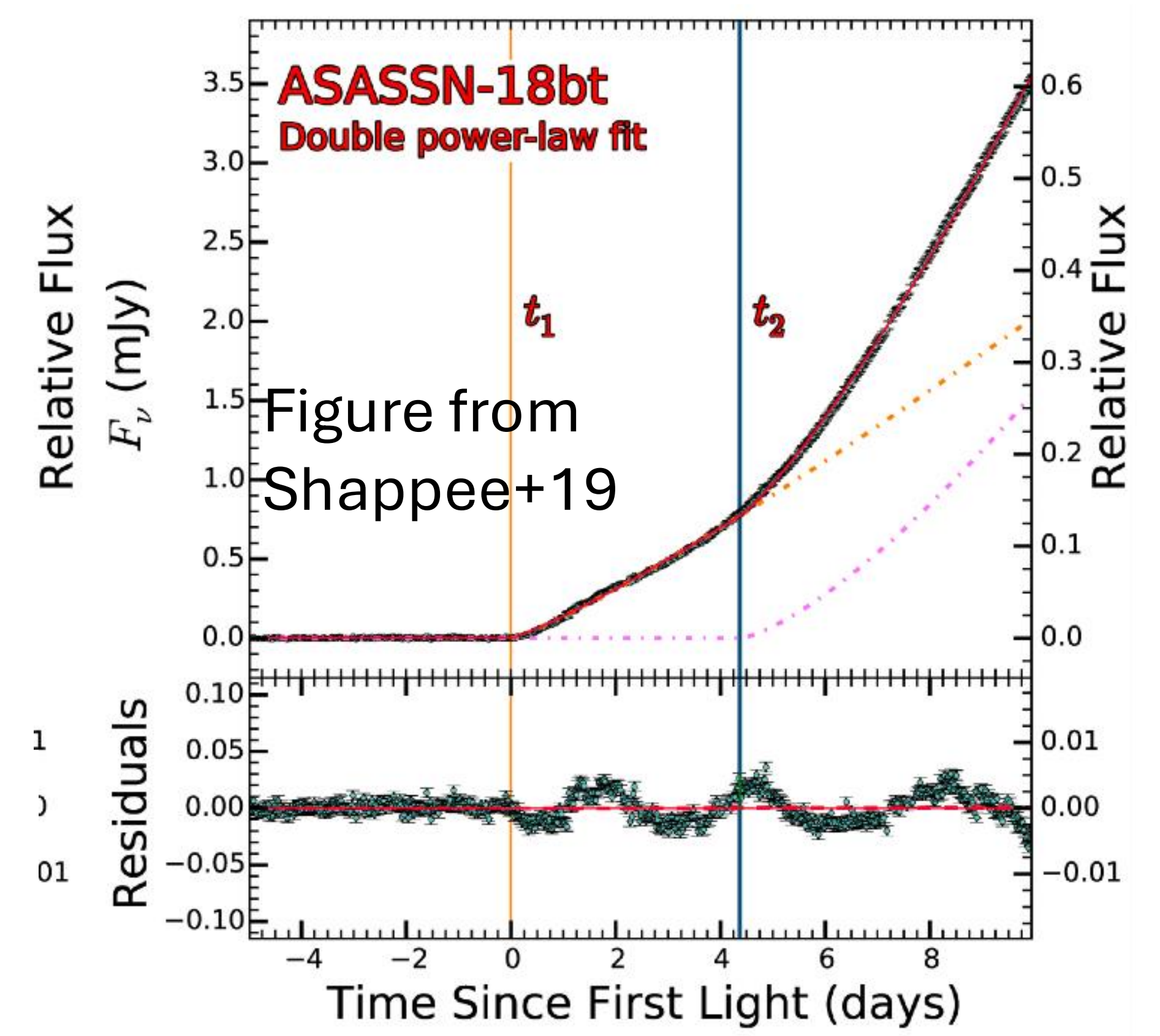
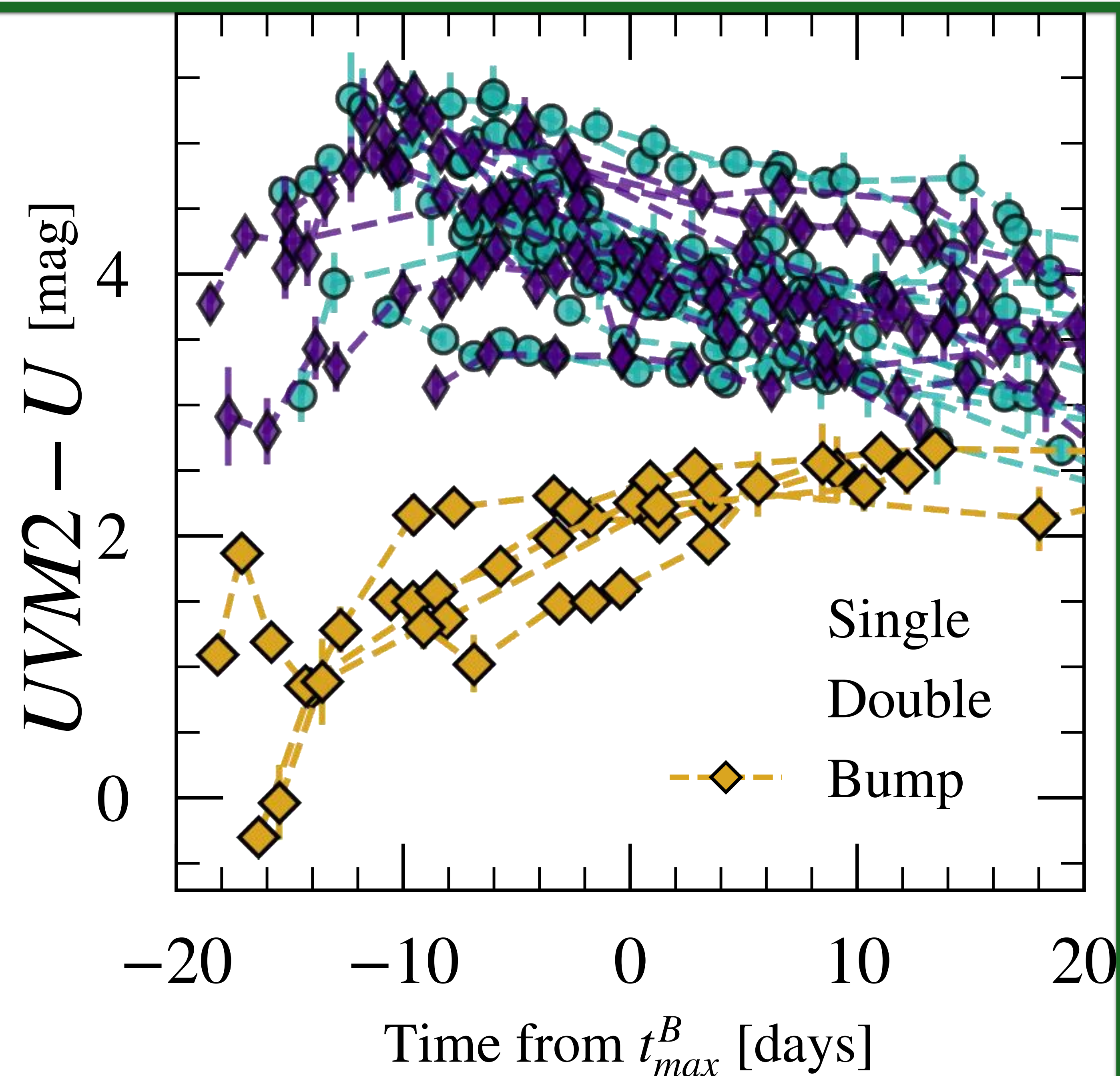


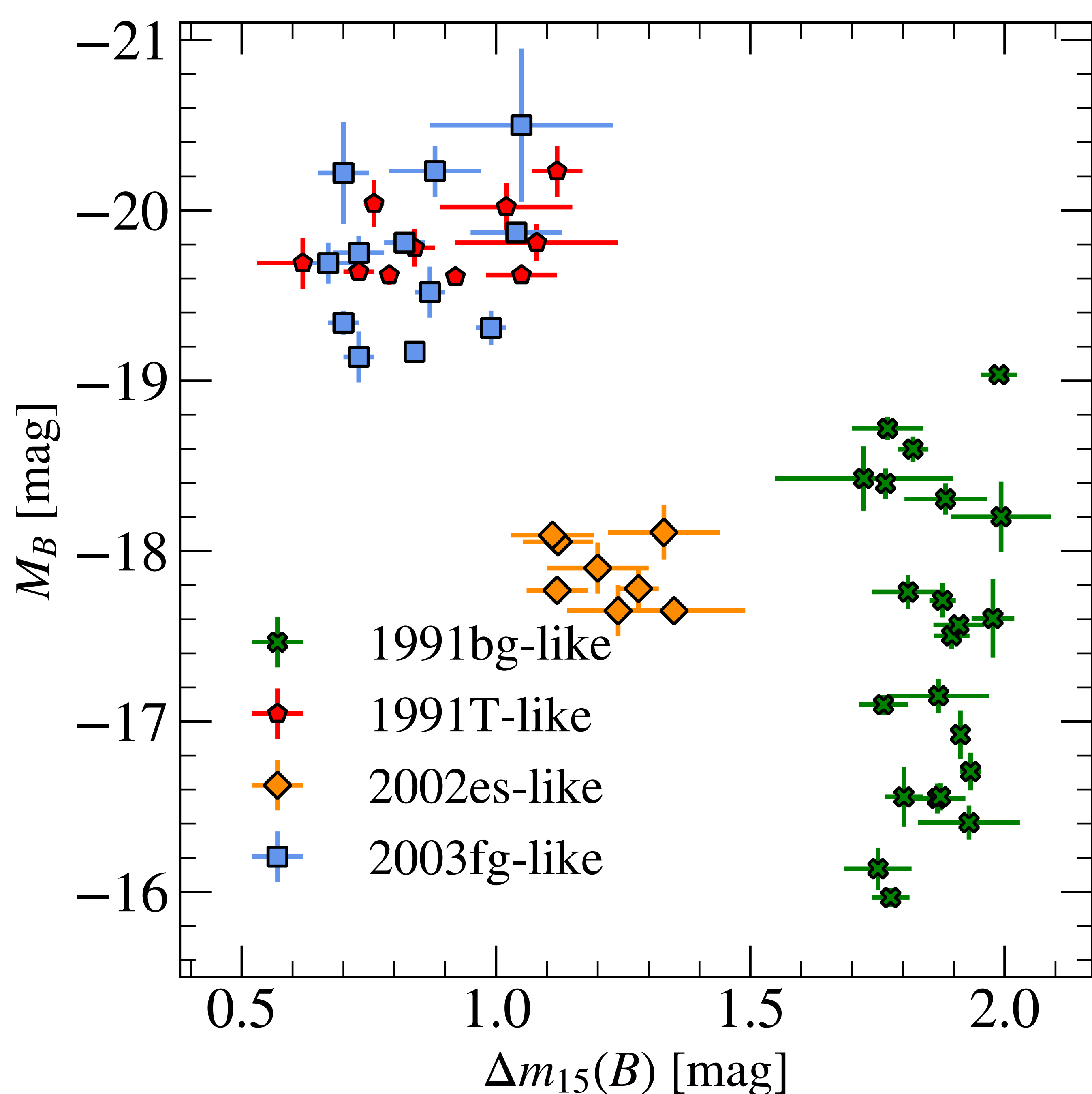
Figure from Shappee+19

SNe Ia are thought to be the explosions of carbon/oxygen white dwarf stars. However, differences in either the progenitor scenario or explosion mechanism may cause excess flux in the rising light curve. We find that “single” and “double” rising SNe Ia have similar UV colors, but that “bump” SNe Ia have persistently blue UV colors! Furthermore, bumps have only been observed in two peculiar SNe Ia subtypes: 2002es-like and 2003fg-like SNe Ia. While in different regions of the luminosity-width phase space for SNe Ia (see below), they may be more similar than meets the eye.



Single
Double
Bump

The diversity of SNe Ia explosions may help us understand their underlying progenitor scenario(s). By confirming a model for peculiar SNe Ia, we can rule that model out for normal SNe Ia. The plot below shows a light curve shape parameter versus absolute magnitude.



One model for explaining the rising light curve bumps is to have an enshrouding cloud of circumstellar material around the exploding carbon and oxygen white dwarf. These models may also be able to explain the persistently blue UV colors as well.

