Rapidly Rising Transients from Subaru/HSC Transient Survey

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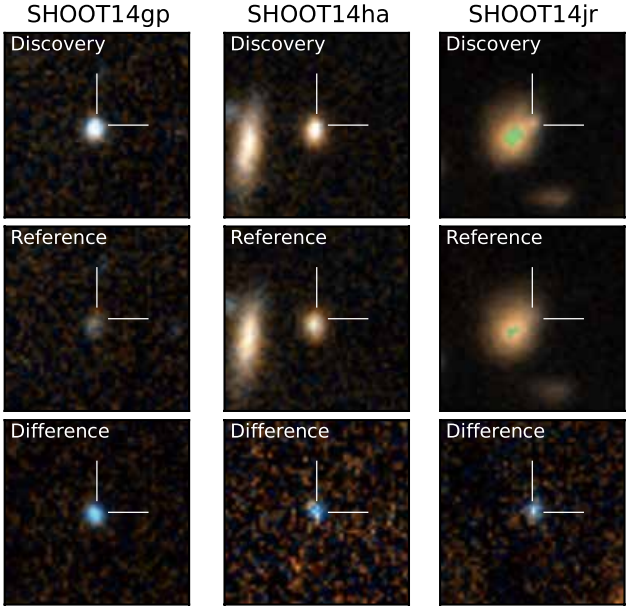

Figure 1: Images of rapidly rising transients (*g*- and *r*- band two-color composite images, 8″ × 8″ size). Three objects out of the five samples are shown. From top to bottom, each panel shows the discovery images, references images and difference images.

The transient sky has been intensively explored by various surveys in the last decade. One of the important discovery spaces for transient surveys is phenomena with a short timescale less than ~ 1 day. There are, in fact, several theoretical expectations for short-timescale transients, such as supernova (SN) shock breakout (~ 1 hr) and the subsequent cooling emission (a few days). In addition to these, there might also be unknown kind of transients with a short duration since our knowledge on the short-timescale transients is still limited.

To explore the short-timescale transient sky, we have performed a high-cadence transient survey with the Subaru telescope and Hyper Suprime-Cam (HSC). We discovered five transients at $z = 0.384-0.821$ (Figure 1) showing the rising rate faster than 1 mag per 1 day in the restframe near-ultraviolet wavelengths. The absolute magnitudes of the five objects range from −16 to −19 mag in the restframe near-ultraviolet wavelengths, and they all show blue colors, $g - r < -0.2$ mag. The rising

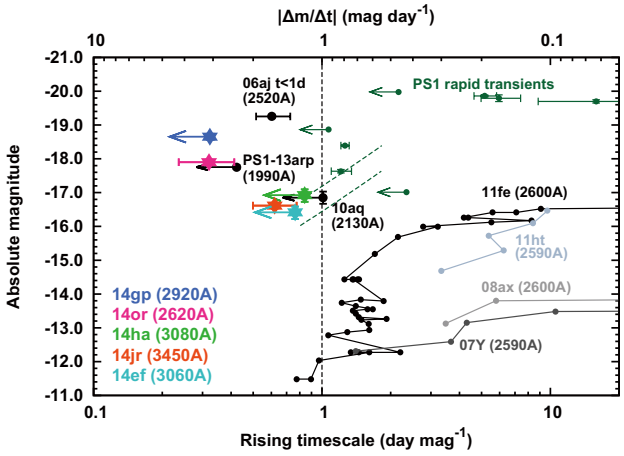

Figure 2: Summary of absolute magnitudes and rising timescale of transients.

rate and brightness of our samples are the most similar to those of the very early phase (< a few days after the explosion) of core-collapse SNe, such as SN 2010aq and PS1-13arp detected by *GALEX* at the very early phases (Figure 2). A conservative estimates suggest that the event rate of rapidly rising transients is higher than ~ 9 % of core-collapse SN rates.

We find that the light curves of the three faint objects agree with the cooling envelope emission from the explosion of red supergiants. The other two luminous objects are, however, brighter and faster than the cooling envelope emission. We interpret these two objects to be the shock breakout from dense wind with the mass loss rate of ~ $10^{-3}\,M_{\odot}\,\mathrm{yr}^{-1}$, as also proposed for PS1-13arp. This mass loss rate is higher than that typically observed for red supergiants. The event rate of these luminous objects is higher than ~ 1 % of core-collapse supernova rate, and thus, our study implies that more than ~ 1 % of massive stars can experience an intensive mass loss at a few years before the explosion.

Reference

[1] Tanaka, M., et al.: 2016, *ApJ*, **819**, 5.