The Rise and Peak of the Luminous Type IIn SN 2017hcc/ATLAS17lsn from ASAS-SN and Swift UVOT Data

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INTRODUCTION

Type IIn supernovae (SNe) are a heterogenous class of stellar explosions associated with the deaths of massive stars surrounded by dense circumstellar environments created by strong mass-loss episodes (e.g., Smith 2014). In these objects, the interaction between the SN ejecta and a dense, H-rich circumstellar envelope dominates the evolution of their light curves and spectra.

SN 2017hcc/ATLAS17lsn was discovered as an optical transient on UT 2017 Oct. 2.38 by the Asteroid Terrestrial-impact Last Alert System (ATLAS; Tonry 2011) at an orange filter magnitude of $o = 17.44$ mag (TNS 13920[1]). Its non-detection by ATLAS on 2017 Sep. 30.43 ($o \lesssim 19.04$ mag) showed that the transient was caught early. We obtained a low resolution optical spectrum on Oct. 7.4 with FLOYDS mounted on the FTS 2m telescope at the Siding Spring Observatory that showed the characteristics of a young Type IIn SN at $z = 0.0173$ (TNS 1284[2]).

[1] https://wis-tns.weizmann.ac.il/object/2017hcc/discovery-cert
[2] https://wis-tns.weizmann.ac.il/object/2017hcc/classification-cert

OBSERVATIONS AND ANALYSIS

We have been obtaining observations of SN 2017hcc as part of the All-Sky Automated Survey for Supernovae (ASAS-SN; Shappee et al. 2014) using the quadruple 14-cm "Brutus" telescopes in Haleakala, Hawaii, and the recently installed quadruple 14-cm "Bohdan Paczynski" telescopes in CTIO, Chile. The ASAS-SN images are reduced by an automated difference imaging pipeline and the magnitudes of sources are calibrated using standard V ("Brutus") or SDSS g-band ("Paczynski") photometry of local standard stars from the APASS DR9 (Henden et al. 2012). The SN was undetected by ASAS-SN down to $V/g \lesssim 17-18$ mag on 2017 Sep. 29-30 and first detected rising at $V = 15.98 \pm 0.15$ on Oct. 7.4. Now it has reached peak magnitude at $V \simeq 13.7$ mag. We show the current ASAS-SN light curve in Fig. 1.

We triggered *Swift* ToO observations that started on Oct. 28.4. The near-UV and optical colors of SN 2017hcc are consistent with a hot (but cooling) blackbody temperature with $W1-U \simeq -0.4$ mag on Oct. 28.4 and $W1-U \simeq 0.0$ mag on Nov. 19.6. The SN is undetected in X-rays with the *Swift* XRT (Chandra et al. 2017) and shows very strong continuum polarization at optical wavelengths (Mauerhan et al. 2017). We obtained new spectra on 2017 Oct. 20-21 with WFCCD on the du Pont 2.5m telescope at Las Campanas Observatory. The spectra are characterized by a strong blue continuum with Balmer and He I emission lines (see top right panel of Fig. 1), with line profiles characteristic of Type IIn. We measure a better constrained redshift of $z = 0.0168$ ($D \simeq 73$ Mpc).

We used a blackbody function to fit the spectral energy distribution (SED) of the SN using the *Swift* data and correcting for Galactic extinction (bottom left panel of Fig. 1). The fits show a hot, decreasing blackbody temperature and an increasing blackbody radius, consistent with early observations of SNe. Assuming a fixed temperature for the early rise of the light curve where there is only ASAS-SN data, we obtain the bolometric light curve of SN 2017hcc shown in the bottom right panel of Fig. 1. The bolometric luminosity at peak $\mathrm{L_{bol,peak}} = (1.34 \pm 0.14) \times 10^{44}$ erg s^{-1} ($\mathrm{M_{V,peak}} \simeq -20.7$ mag), makes SN 2017hcc one of the most luminous Type IIn SNe known (e.g., Smith et al. 2007; Ofek et al. 2014; Jencson et al. 2016). From the bolometric light curve we constrain the risetime to be ~ 27 days and the total radiated energy of the event to date is $\sim 4 \times 10^{50}$ erg.

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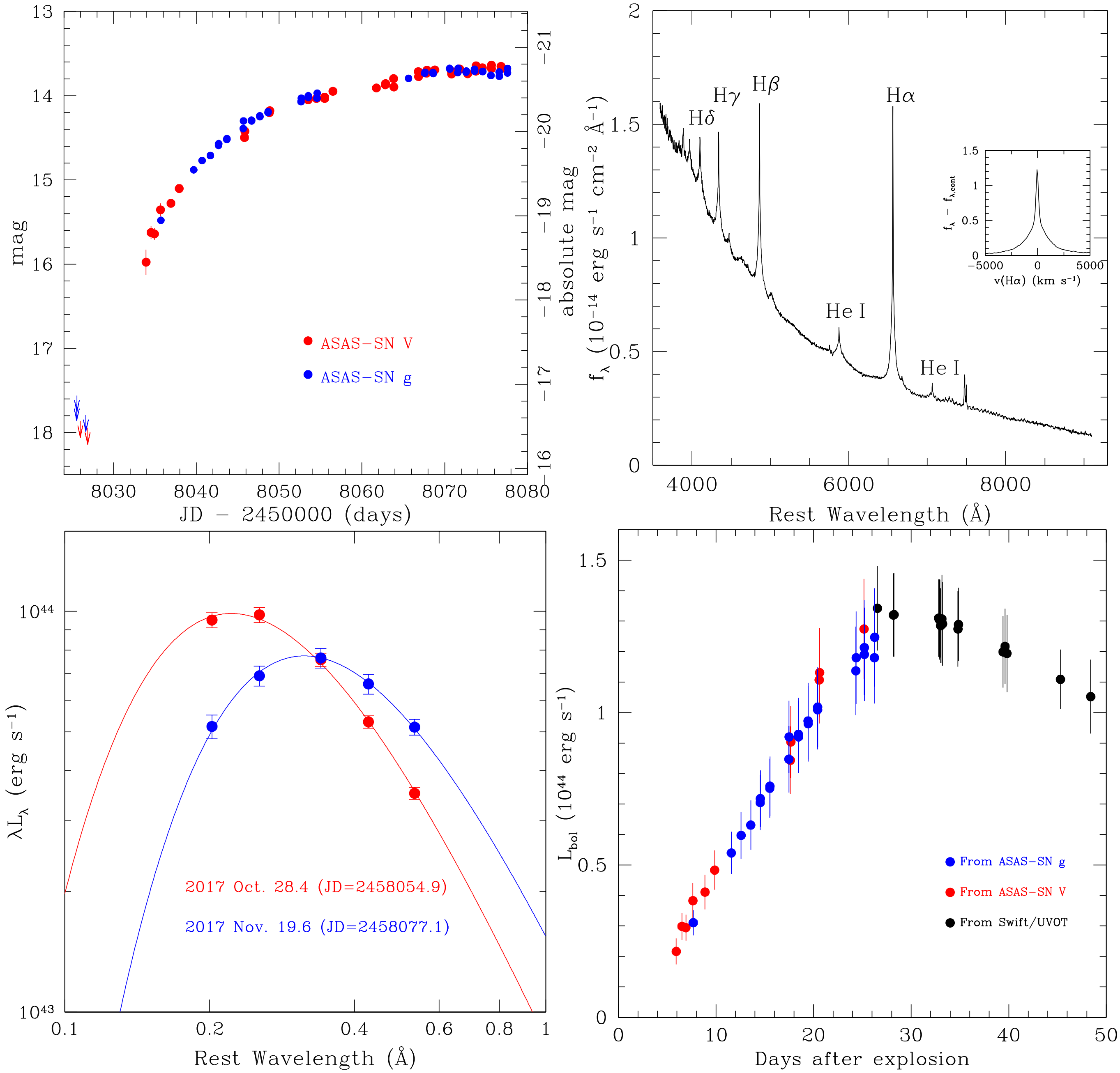

Figure 1. *Top Left*: ASAS-SN V (red) and g-band (blue) light curves of SN 2017hcc. *Top Right*: du Pont spectrum obtained on UT 2017 Oct. 20.08 showing a blue continuum and the characteristic features of a Type IIn SN. *Bottom Left:* SED evolution obtained from observations at near-UV and optical wavelengths with the *Swift* UVOT. The lines show blackbody model fits with $\mathrm{T_{bb}} = 16539 \pm 343$ K and $\mathrm{R_{bb}} = (1.59 \pm 0.07) \times 10^{15}$ cm on UT 2017 Oct. 28.4 (red) and $T_{bb} = 11657 \pm 238$ K and $\mathrm{R_{bb}} = (2.83 \pm 0.08) \times 10^{15}$ cm on UT 2017 Nov. 19.6 (blue). *Bottom Right:* Evolution of the bolometric luminosity as a function of time. For the early rise (blue and red points) of the light curve we assume a blackbody SED with the temperature fixed to $\mathrm{T_{bb}} = 16539$ K obtained from the earliest Swift UVOT photometry to estimate a bolometric correction to the ASAS-SN V and g-band photometry. For the later part of the light curve (black points), we derive the bolometric luminosity directly from blackbody fits to the *Swift* UVOT photometry.