The ZTF Bright Transient Survey

— a *spectroscopic* census of the dynamic sky

ZTF Website *BTS Website*

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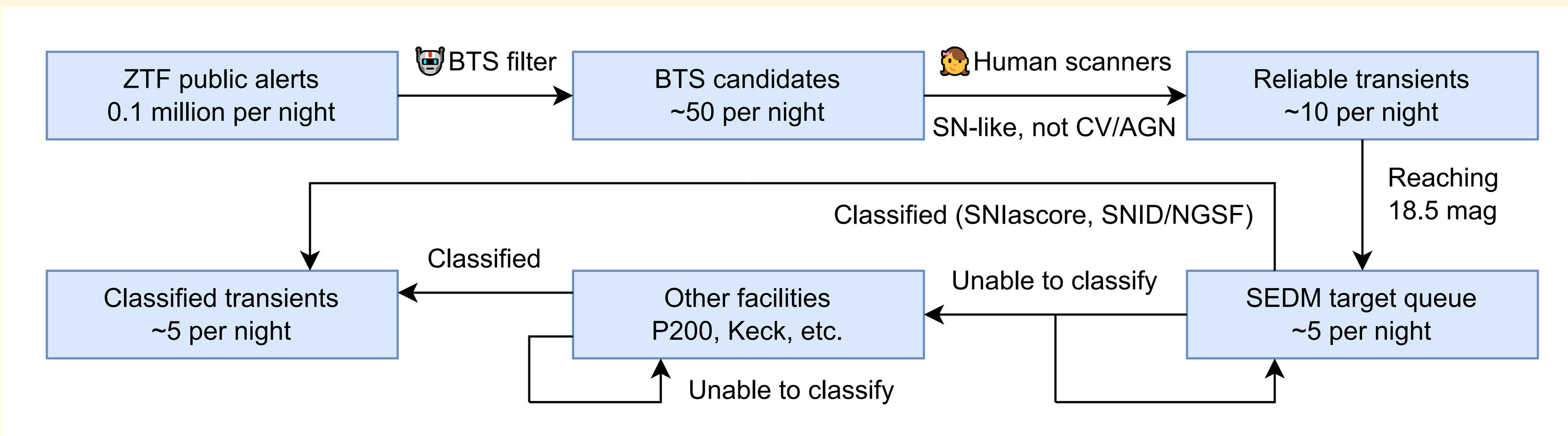
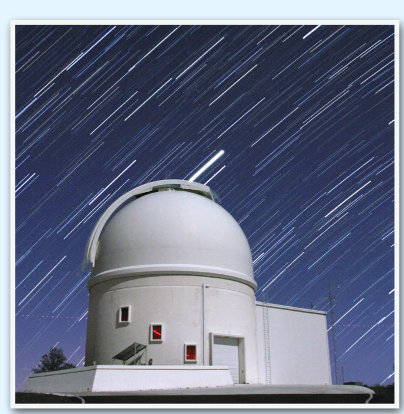
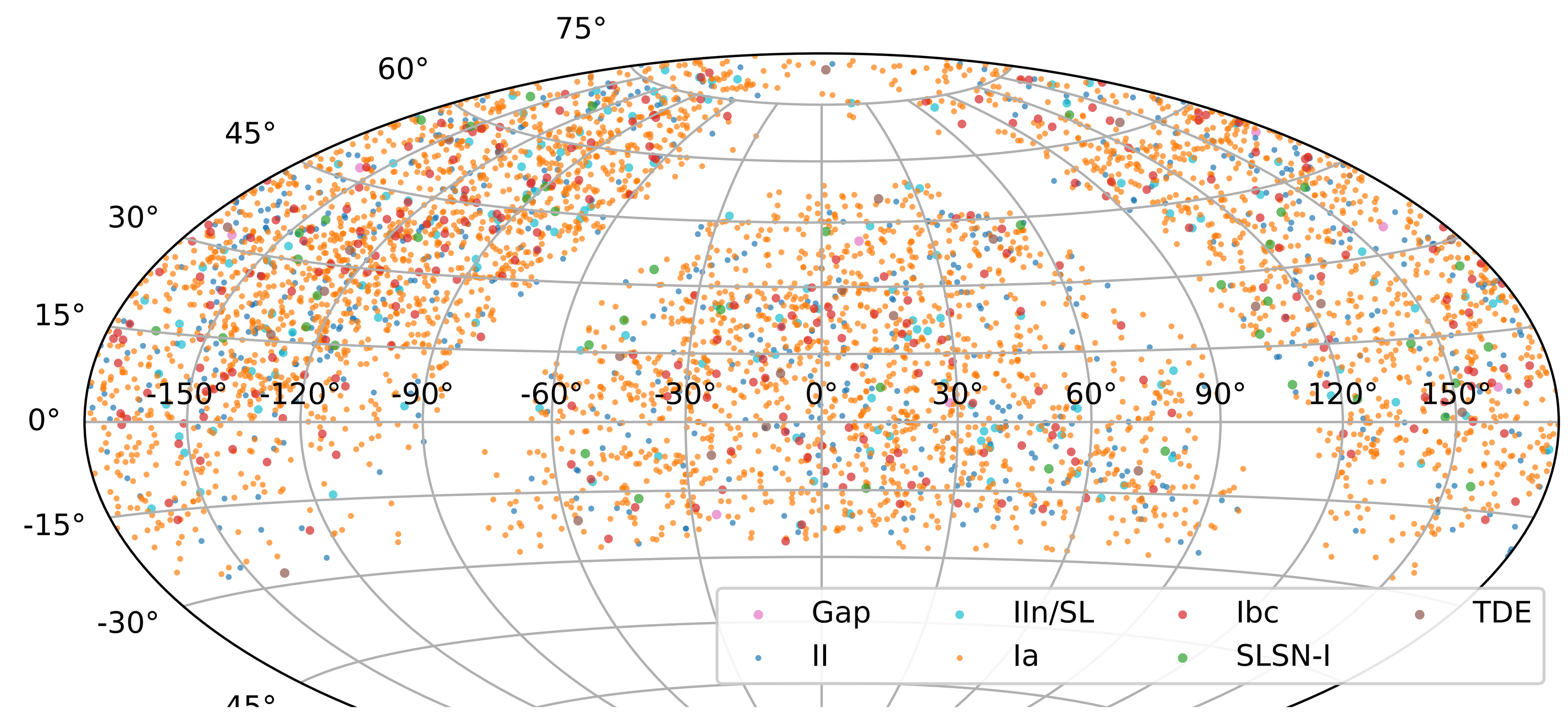
The Zwicky Transient Facilitiy Bright Transient Survey (BTS) is currently the *largest* spectroscopic census of transients, including supernovae and other energetic phenomena. ZTF detects transients through imaging, but detailed knowledge about transients, particularly their subclasses and hence the underlying physical processes, can only be obtained by taking spectra — a more time-consuming endeavor than taking images. A comprehensive and unbiased spectroscopic census uncovers the demographics of transients, including subclasses, brightness, color, and duration, providing insights into the late-time evolution of stars, their impact on galaxy formation and evolution, and the origins of chemical elements.

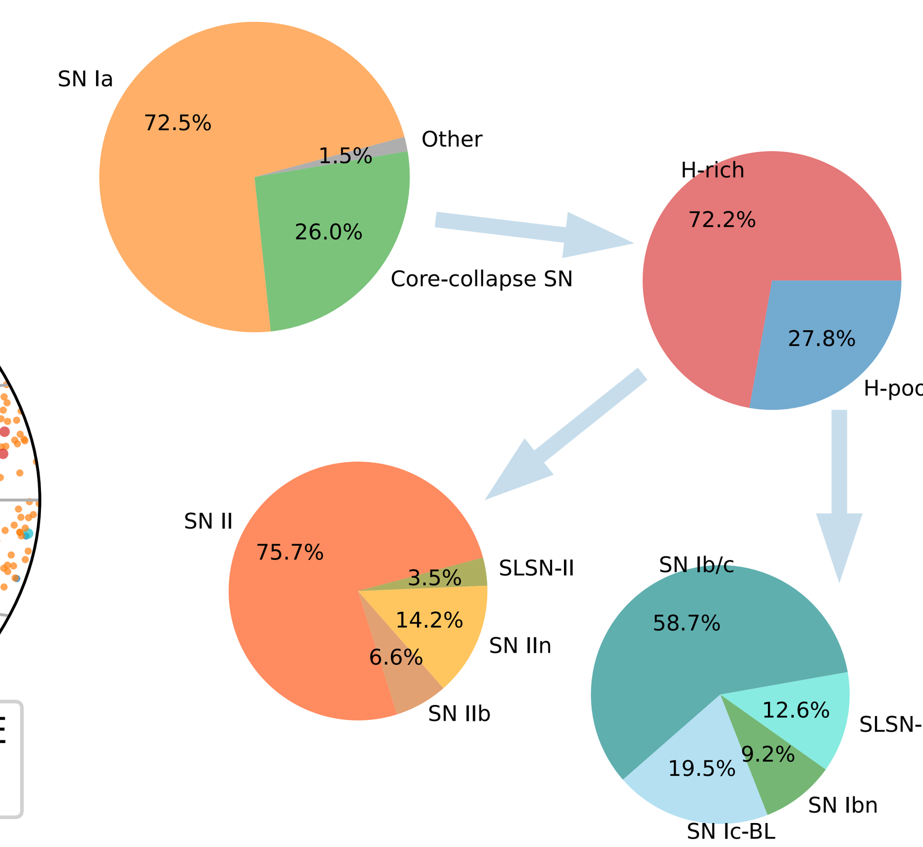


ZTF images the northern sky once every two nights and detects new objects or brightness changes in known objects, but only a fraction of these are transients like supernovae. Using a combination of carefully designed criteria ("filters"), human visual inspection ("scanning"), and, more recently, computer vision-based techniques, we identify about ten bright transients per night and assign them for follow-up observations if they are expected to reach 18.5 magnitude — about one hundred million times fainter than Sirius, the brightest star in the winter sky, yet still six times brighter than the faintest object ZTF can detect.

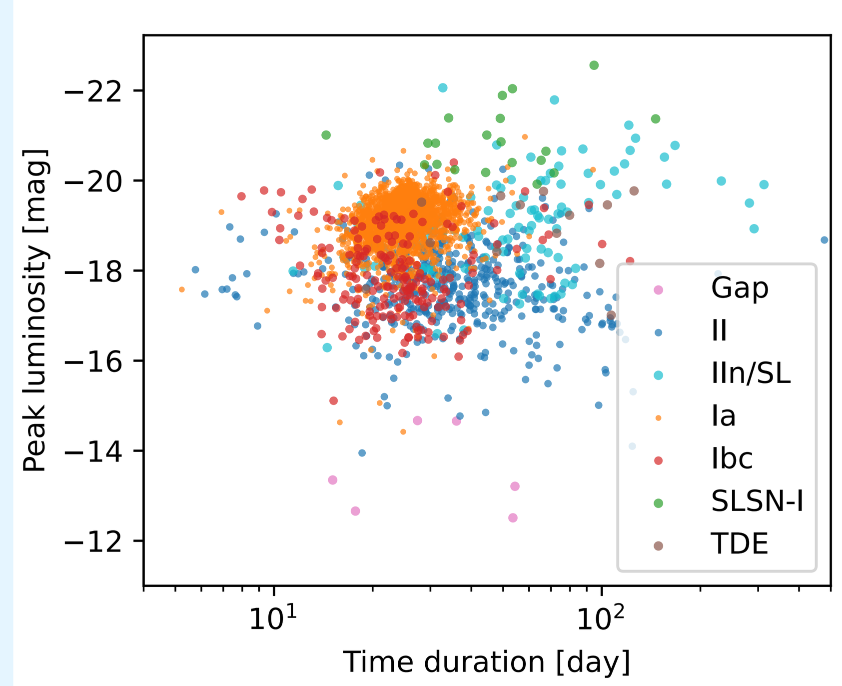
We observe every transient brighter than 18.5 mag using the SEDM spectrograph on Palomar's 60-inch telescope. For better sensitivity or resolution, we also use Palomar's 200-inch Hale telescope or the 10-meter Keck telescope. We classify transients using their spectra, then immediately announce our discoveries and release the data to the Transient Name Server. By adhering to this strict brightness criterion, we have accumulated a large sample of transients with unprecedented uniformity — essential for statistical studies of their demographic properties.

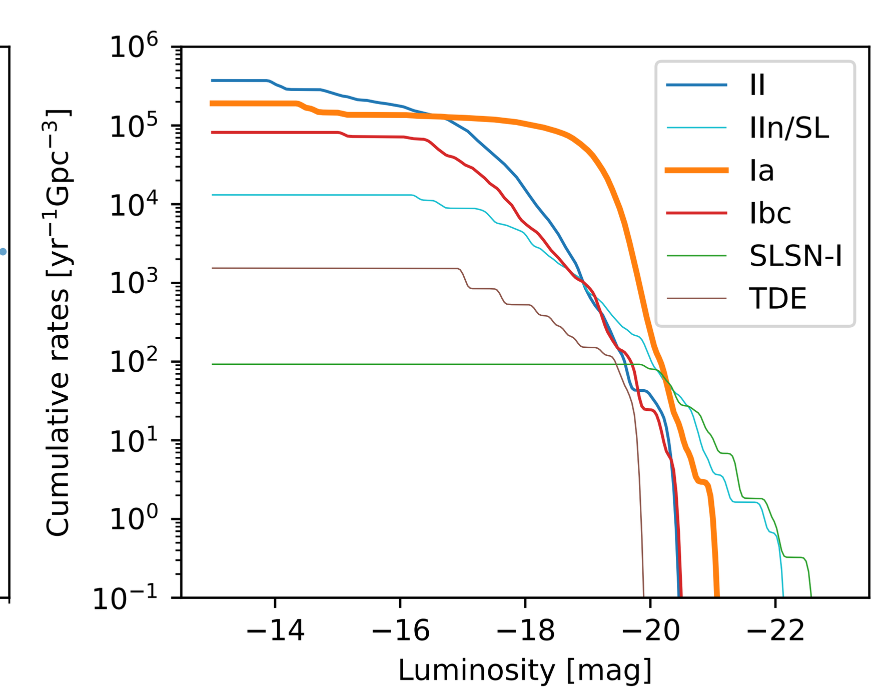




Since 2018, we have gathered over 14,000 spectra and classified 8,851 transients. Over 95% of the transients brighter than 18.5 mag have spectra available, constituting the largest uniform sample of transients to date.

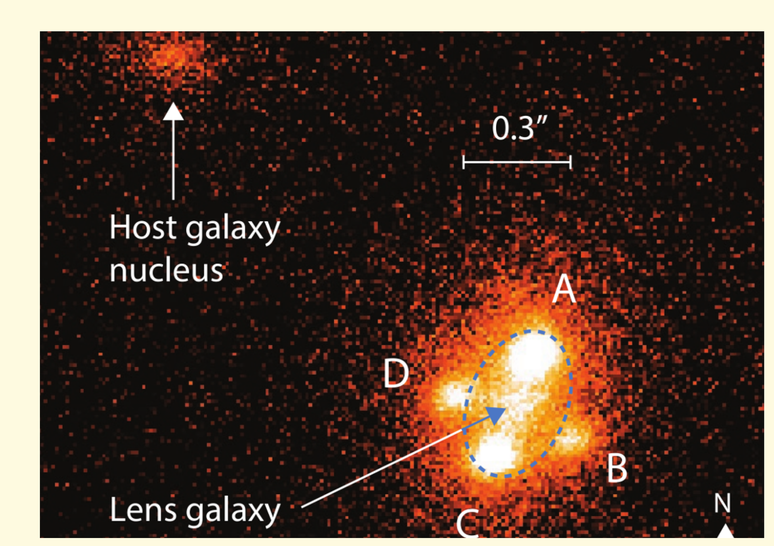
This large sample allows us to explore the landscape of transients. For example, the luminosity-time duration relationship of common supernova subclasses *(left)* and the supernovae rates in the nearby universe *(right)*, a critically important measurement that connects stellar evolution to galaxy formation.





This unbiased spectroscopic survey also identifies unusual transients. Here is a distant supernova, 'SN Zwicky', whose brightness has been amplified by gravitational lensing. Adaptive Optics images from Keck reveals four images of the same supernova.

Rare Gems!



SN 2022qmx, Goobar et al. (2023)

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