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What is this? WIT objects and other serendipity discoveries in the VVV/VVVX survey

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The WIT objects (short for What Is This?) are sources that defy classification found in the near-IR database of the VISTA Variables in the Vía Láctea (VVV) survey and its extension the VVVX survey. Here we summarize some specific cases of these previously unclassified variable sources.

We have been monitoring the Galactic bulge and southern disk in the near-IR using the VISTA telescope at ESO Paranal Observatory since year 2010. Massive searches for variable stars have been carried out in this vast database, resulting in the discovery of $> 10^6$ variables, including eclipsing binaries, RR Lyrae, Miras/LPVs, δ Scuti stars, classical Cepheids, type II Cepheids, novae, microlensing events, etc. These catalogs of variable stars have wide applications for studies of stellar populations, stellar formation and evolution, star clusters, and Galactic structure (e.g., Ferreira Lopes et al. 2020, Navarro et al. 2020, Herpich et al. 2021, Molnar et al. 2022).

Interestingly, within our database we have also found some objects that defy classification, and therefore we labeled them as WIT objects. Upon closer inspection, in the end some of the candidate WITs turn out to be observational glitches. Some of them appear fit into the previously known kinds of objects, but that are observed through extreme conditions like very high extinction. However, a few of them appear to be manifestations of new astrophysical phenomena, with light curves that exhibit unique peculiarities. These WIT objects represent a wide variety of extreme or rare sources, including for example:

• VVV-WIT01, a very reddened novae or supernova or a protostellar collision (Lucas et al., 2019).

• VVV-WIT04, an extragalactic radio source violently variable in the near-IR (Saito et al., 2019a).

• VVV-WIT06, an extreme infrared transient as a probable dusty nova (Minniti et al., 2018).

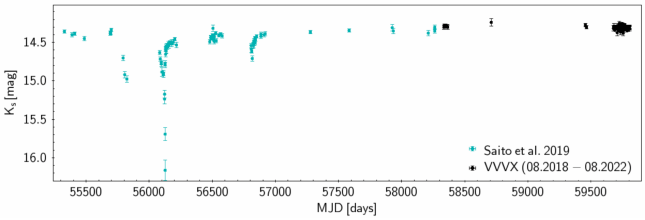

Figure 1. Ks-band light curve for VVV-WIT07 covering a 12-year baseline, including VVV and VVVX data.

• VVV-WIT07 (Figure 1), that is likely another Tabby star or Mamajek object (Saito et al., 2019b).

• VVV-WIT08, a disappearing source, nicknamed 'the giant that blinked' (Smith et al., 2021).

• VVV-WIT12, an unusual long period source that induces variability in its surrounding nebula, probably a light echo (Saito et al., 2023).

New classes of variable stars emerge, as illustrated by the discovery of the dipping giants (Lucas et al., 2024). They constitute a population of aperiodic late-type giant stars with extreme variability, that suggests the presence of deep extinction events. They are strongly clustered in the nuclear disc of the Milky Way, suggesting that they are very metal-rich giants undergoing high mass loss.

In most cases spectroscopic follow-up observations are needed to properly characterize the rare sources. These WIT objects, some of which were initially serendipitous discoveries, are now subject to a more systematic search in the rich VVVX database. Our work also underscores the need to take into account serendipity in future large surveys. To placate some critics, we note that these are not mere fishing expeditions, because new science is emerging…

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