Analysis of physical processes in eruptive YSOs with near infrared spectra and multi-wavelength light curves

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Abstract

The decade-long Vista Variables in the Via Lactea (VVV) survey has detected numerous highly variable young stellar objects (YSOs). We present a study of 61 highly variable VVV YSOs combining near infrared spectra from Magellan and VLT with VVV and NEOWISE light curves to investigate physical mechanisms behind eruptive events. Most sources are spectroscopically confirmed as eruptive variables (typically Class I YSOs) but variable extinction is also seen. Among them, **magnetically controlled accretion**, identified by HI recombination emission, is observed in **47 YSOs**. Boundary layer accretion, associated with FU Ori-like outbursts identified by CO overtone and H_2O absorption, is observed only in longer duration events (>5~yr total duration). However, even in long duration events, the **magnetically controlled accretion mode predominates**, with amplitudes similar to the boundary layer mode. We find that the ratio of amplitudes in Ks and W2 can distinguish between variable accretion and variable extinction. 13 YSOs are periodic or quasi-periodic variables. We identify examples of **periodic accretors** and extinction-driven periodicity among them (with periods up to 5~yr) though more data are needed to classify some cases. The data suggest that dynamic interactions with a companion may control the accretion rate in a substantial proportion of eruptive systems.

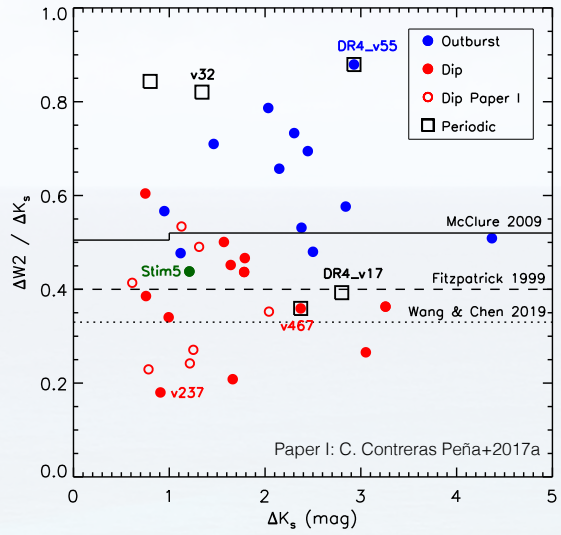

Figure 1: The ratio between WISE W2- and VVV Ks-band amplitude is able to distinguish the variation mechanism (extinction dip, red; accretion burst, blue). Long-term periodic YSOs are shown by black squares.

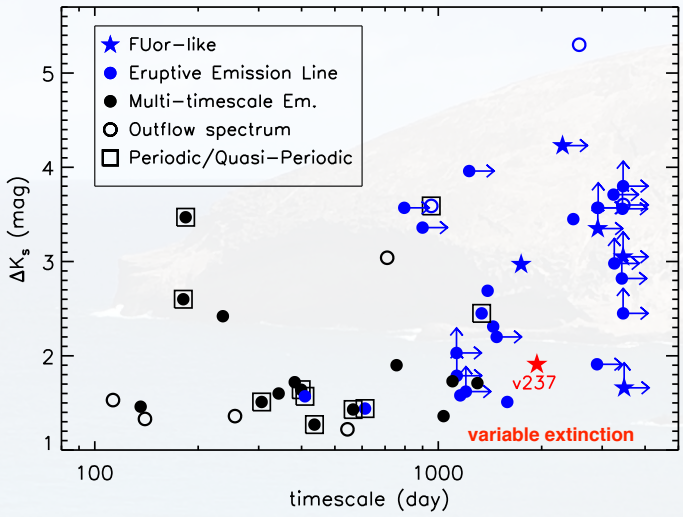

Figure 2: ΔKs and duration of spectroscopic confirmed eruptive YSOs in the VVV survey. Shown by ★, FUor-like YSOs all have long variation timescales, while emission line YSOs (circle) have a wide range of duration. On timescale longer than 2000 days, magnetic field controlled accretion (emission line YSOs) is predominate among Class I sources.

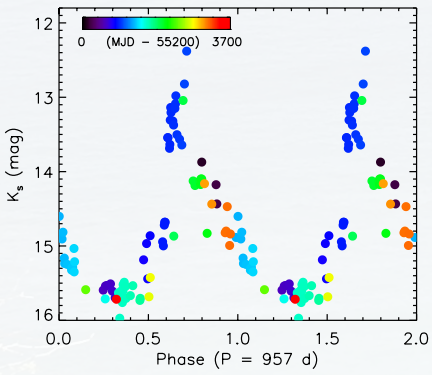

Figure 3: An YSO (Class I) with periodic outbursts. The perturbation from a (sub)stellar companion could modulate the mass accretion process

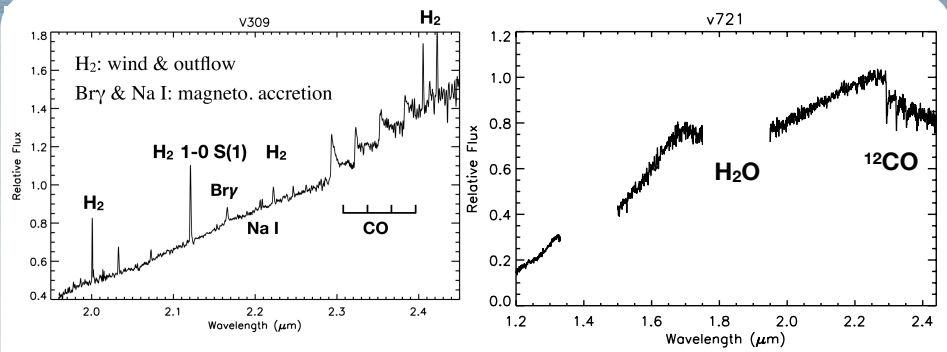

Figure 4: Examples of an Emission line object (v309) and an FUor-like object (v721). Spectral indicators of magnetospheric accretion scenario (Brγ, Na I, and ^{12}CO overtone emission) are seen on emission line objects. Molecular absorption features arose from the self-luminous disc are observed on FUor-like objects.

Summary:

- **61 eruptive YSOs from the VVV survey are spectroscopically confirmed in this work**
- **Magnetospheric accretion mode is predominates on decade-long accretion bursts among Class I objects**
- **FUor-like outburst are only seen with long duration**
- **Periodic accretors were detected as consequence of dynamical interactions from companions**