

Non-degenerate Eruptive Variables

TVS subgroup



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what are they?

MASSIVE STARS

LBVs - normal S Dor
eruptions:

LBVs - giant eruptions like
Eta Car

ILOTs

mergers and violent common
envelope events

Chaotic eruptions

T-Tauri STARS

Fu Ori variables

Ex Or variables

SYMBIOTIC STARS

Symbiotic Stars
(M+WD)

massive stars

peak M

Duration

Cadence

LBVs - normal S Dor eruptions:

-8 to -12 mag

5-10 yr

repeat irregularly 10-20yr

LBVs - giant eruptions like eta car:

-10 to -15 mag,

100 days

repeat irregularly on timescales of

up to - 15 mag

10 yr

centuries to millennia (maybe??)

ILOTs (intermediate luminosity optical transients):

-10 to -15 mag,

100 days

Like 1st LBV peak, no longer time scales

\mergers (?) and violent common envelope events (?):

-8 to -14 mag,

10-100 days

no recurrence but

-7 to -12

2-10 yr

irregular peak variation, *very red*

pre-SN eruptions:

-12 to -15 mag,

100 days

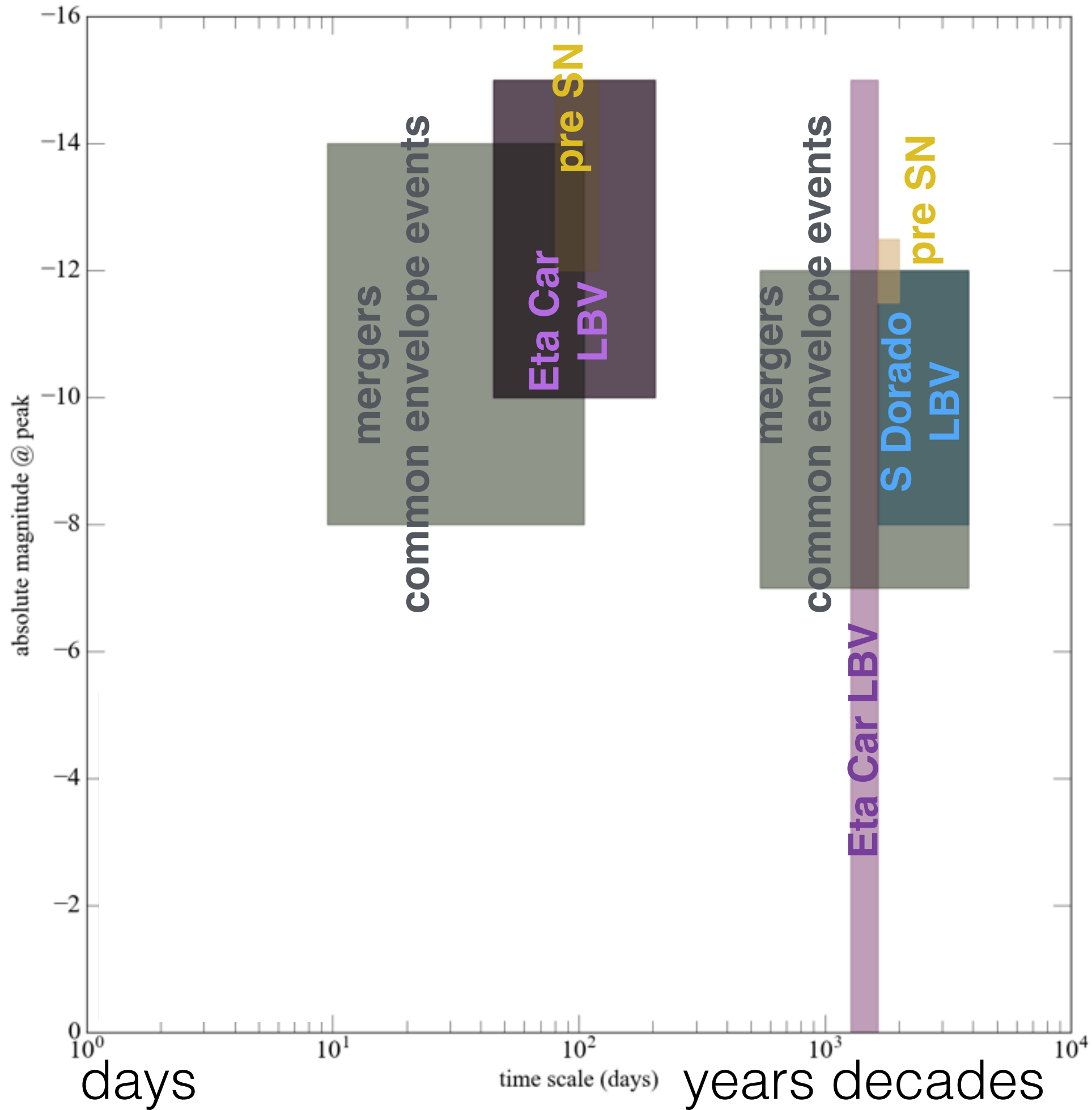
time before SN is 10 days to 10 years

-12

5 yr

can be multiple and repeating, or not

Magnitude



YSOs

$\Delta(M)$

Rise Duration

Total Duration

FuOri variables

>5 mag

months

10 yr

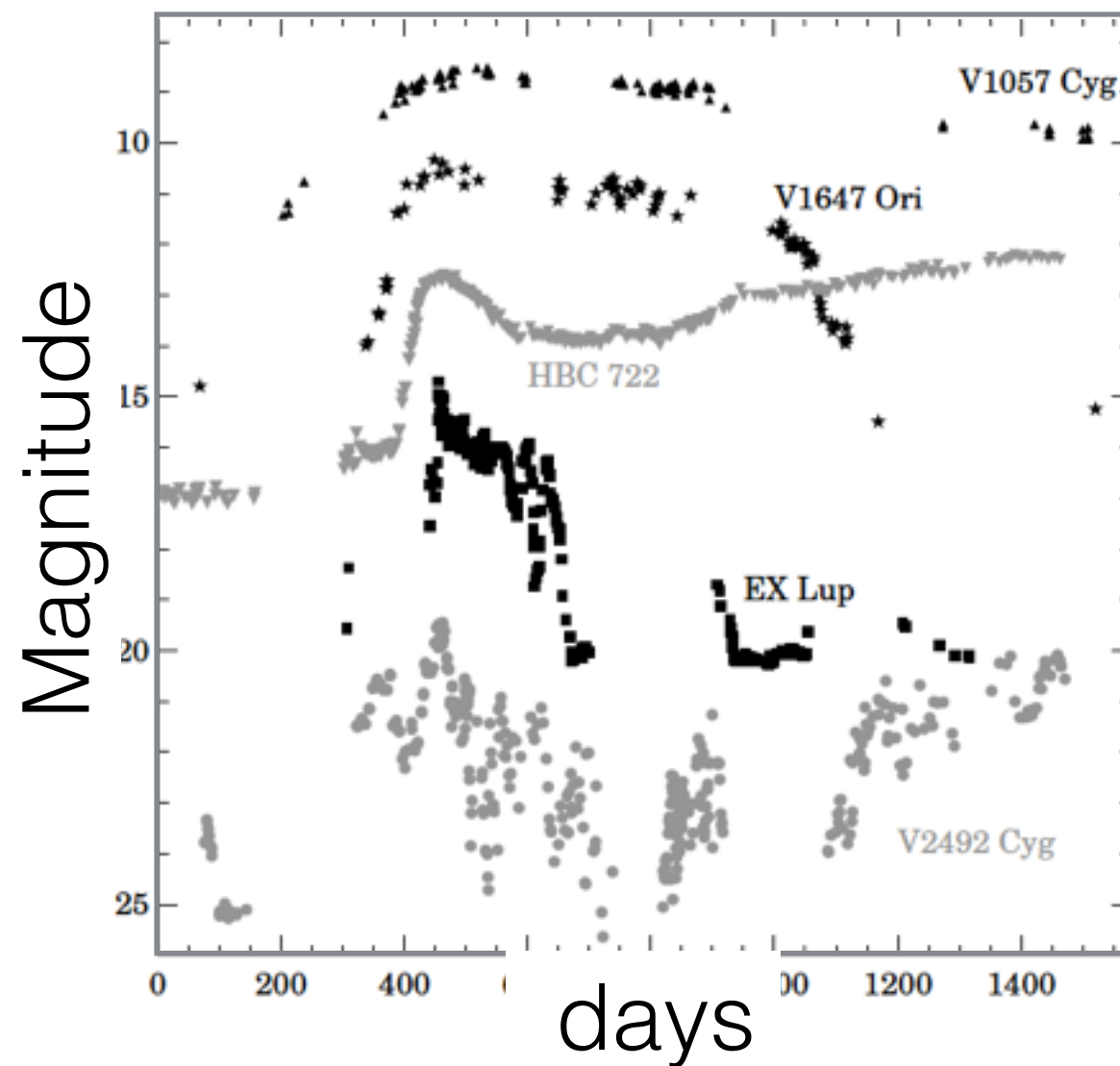
Ex Or variables

<2 mag

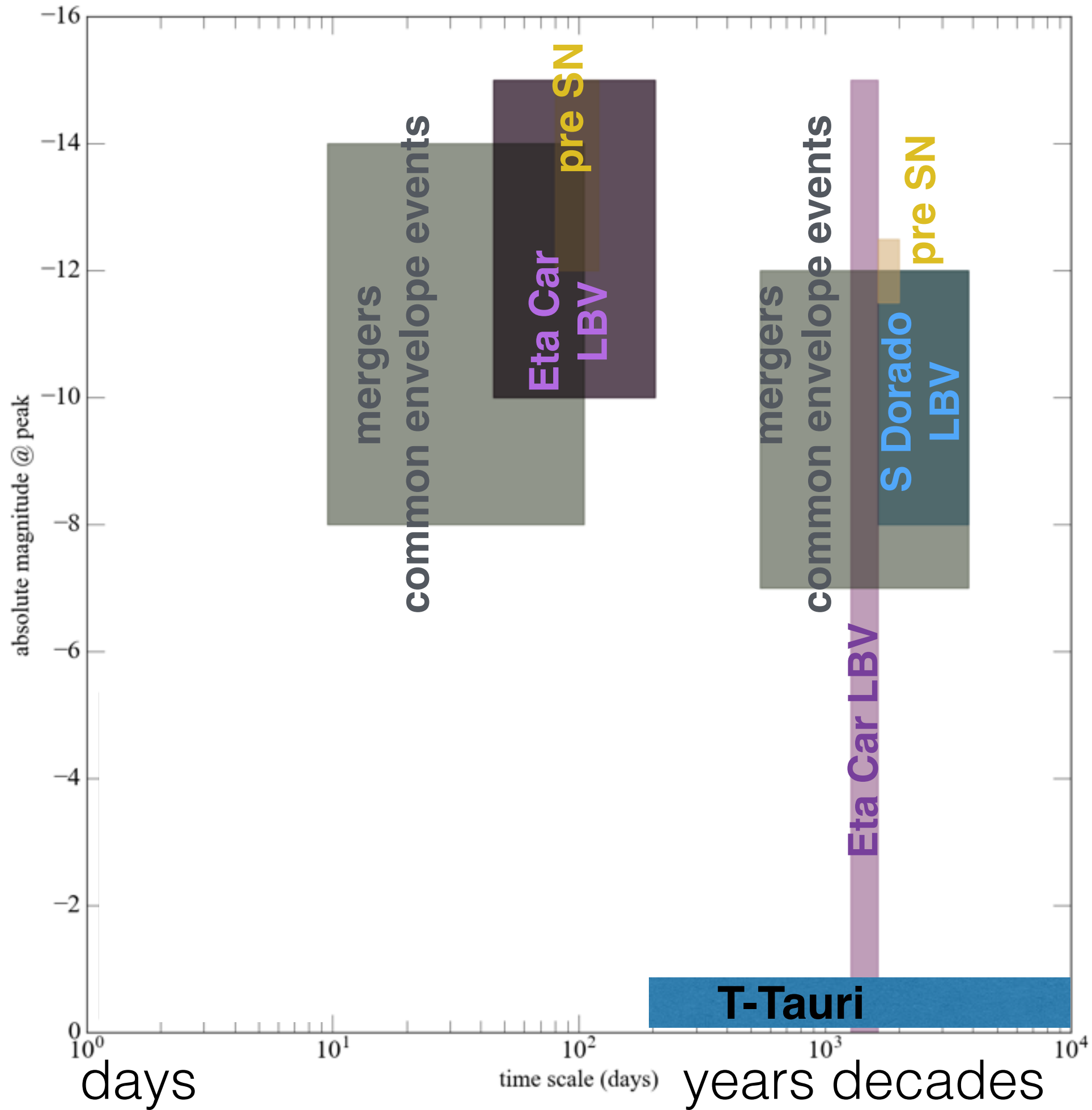
weeks

months - years

RATE: only a few known



Magnitude

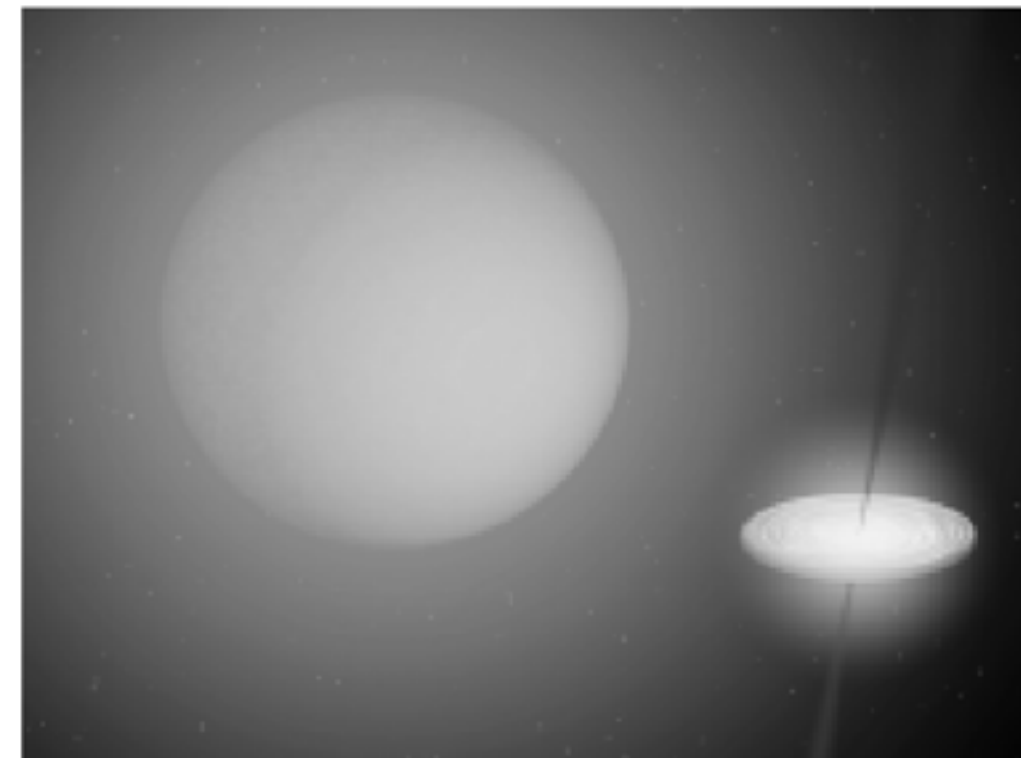
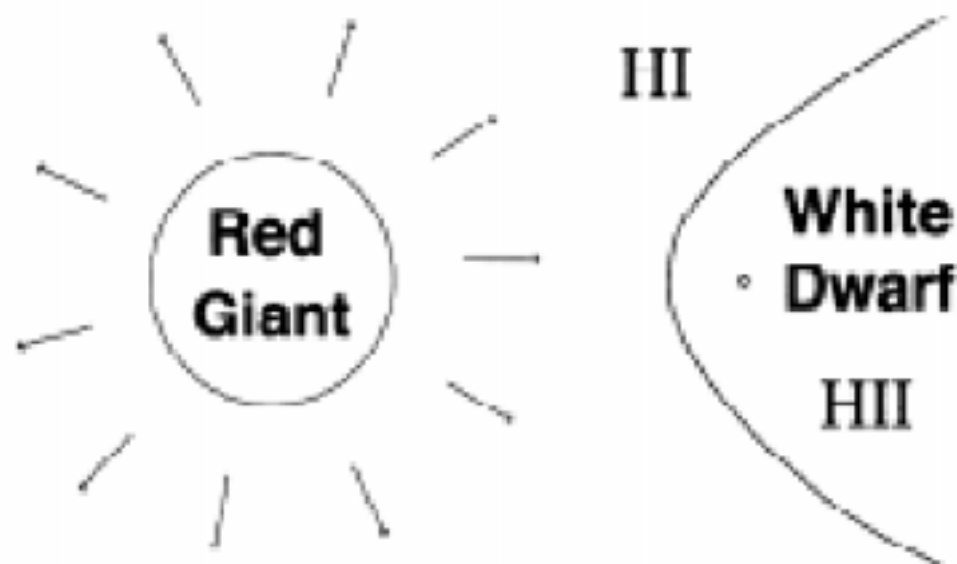


Symbiotic Stars

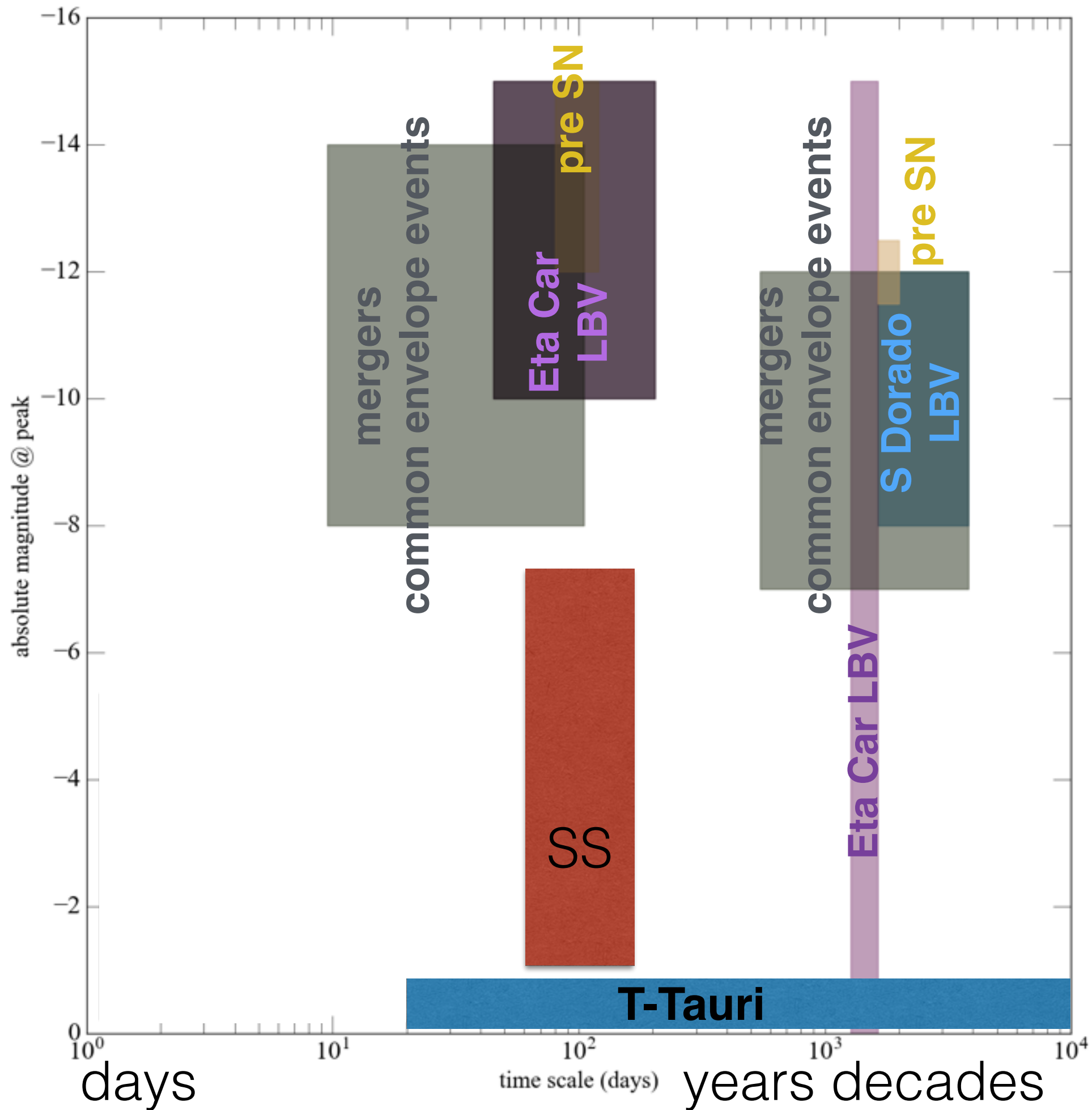
	$\Delta(M)$	<u>M (G,K) type + WD binary</u>	Total Duration
>6 mag			months
1-5 mag			months
RATE: 330 known, 1/2 outbursting <u>associated with jets</u>			

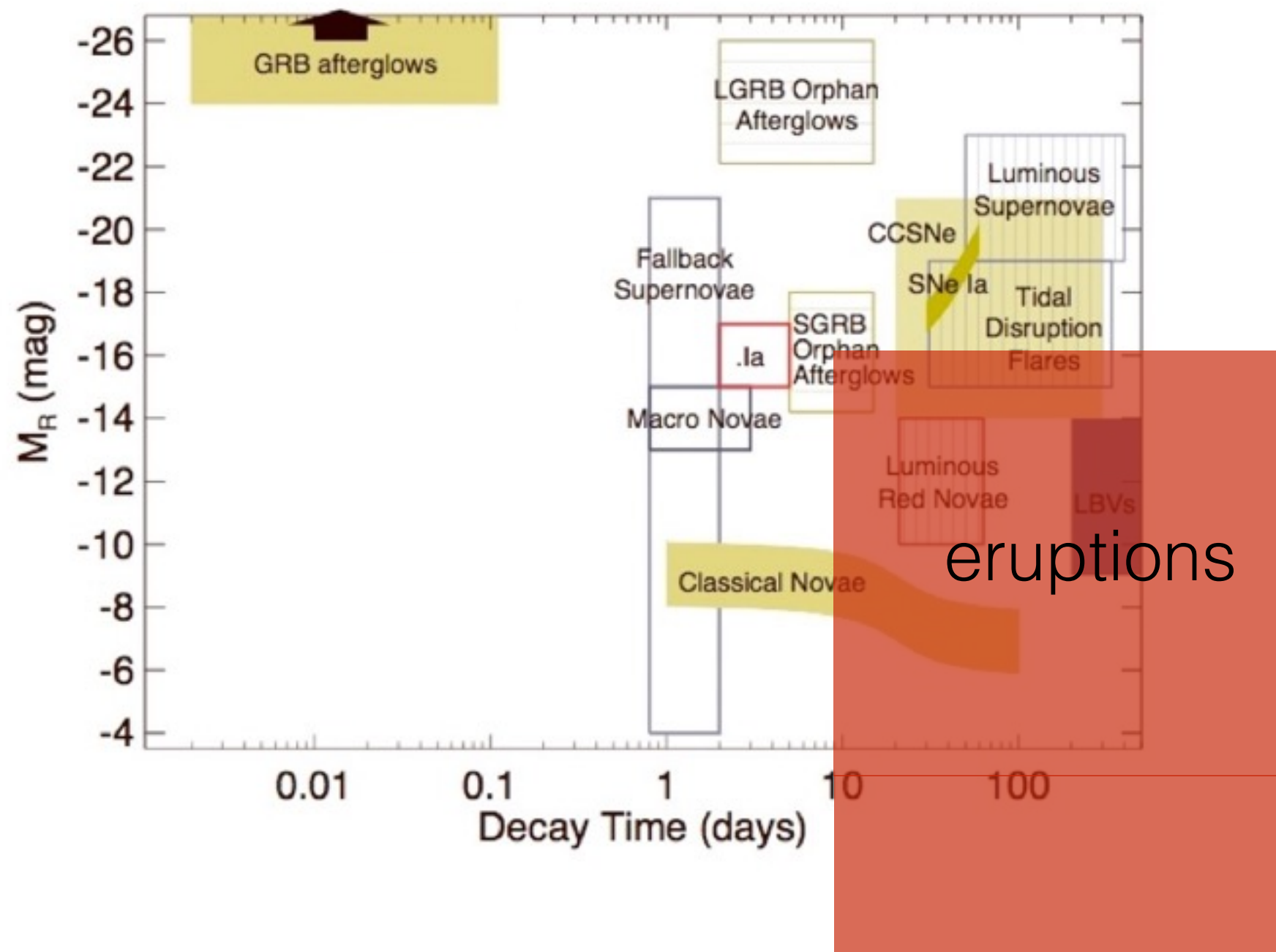
- 1) reveal systems in outburst;
- 2) enable TOO observations (X-ray to radio)
- 3) determine the fraction of symbiotic stars that have outbursts;
- 4) determine basic outburst statistics
- 5) generally characterize symbiotic-star long-term optical variability

Sokoloski 03



Magnitude





fundamental questions

- Understanding late stages of Massive star evolution
- Connection between eruptions and SNe (CC & Ia)
- Do all T Tauri stars undergo FU Ori and Exor outburst during their formation?
- Understanding Accretion: duty cycles of outbursts of different accretion rates (T-Tauri + SS)
- Fraction of final stellar mass accreted during T-Tauri eruptive events

also though more speculative:

- Detections of Chaotic Eruptions (Arnett+Meakin 11)
- Discovery of Extrasolar KBs after ILOTs (Bear+Soker 16)

timeline to answer with LSST

- **Connection to SN explosions:**
 - detection of pre-SN eruptions
 - so far a few in PS1, PanSTARRs
 - wait for SN then look for precursor on time scales days-decades before SN. Also SS for Ia
- SHOULD BE DOABLE WITH ~1YEAR OF DATA**
- NEARLY ANY PROPOSED CADENCE WOULD DO SINCE ERUPTIONS LAST ~DAYS AT LEAST**

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Connections with SN subgroup and DE SN group!

timeline to answer with LSST

- **Understanding late stages of Massive star evolution:**
color is a strong discriminant for ejection mechanism
(winds vs hydrostatic events...)
sampling at the cadence of ~week is generally
sufficient as the duration is long
inference is limited by the slow evolution of the
transients

~1 YEAR should collect+characterize ~100 eruptions

(based on the expected SN detections compared to current surveys, without accounting for a presumably different luminosity function though. anyone did anything better yet??)

Connections with Galactic subgroup!

timeline to answer with LSST

- **Evolutionary sequence:**
looking at association of star types O, LBV, WR
in (relatively) high resolution images
**SHOULD BE DOABLE WITH THE FIRST
STATIC SKY RELEASE (6 month, independent of
cadence)**

Connections with Galactic subgroup & MW collaboration!

timeline to answer with LSST

- T - Tauri questions:
FU Ori and EXor extremely rare: (~dozens sources known in the entire sky - Audard+ 2014).
LSST will allow probing
 - 1) systems deeply embedded in their molecular clouds and envelopes and
 - 2) regions far beyond nearby molecular clouds.**Nearly any proposed cadence will do.**
Longer wavelengths are preferred.

**RARITY IS THE BOTTLE NECK BUT NEW
DISCOVERIES SHOULD HAPPEN QUICKLY +
RESULTS START WITH ~6 MONTH DATA**

Connections with Interactive Binaries subgroup!

timeline to answer with LSST

- SS

monitoring optical eruptions and connecting to jets

Nearly any proposed cadence will do.

Longer wavelengths are preferred.

**MAY NEED PROMPT IDENTIFICATION
FOR FOLLOW UP**

Connections with Interactive Binaries subgroup!

observing requirements

regular sampling, colors.

the time scales are long and the differences are in the recurrence rate, color, lightcurve shape (rise time) but the relevant time scales are always $>$ days: each event can be well characterize by sampling every few days in a few bands.

observationally these events don't have strict requirements: most proposed cadences should work.

other questions and goals??

WHAT HAVE I MISSED??