

史上最大規模の矮新星アウトバースト MASTER OT J030227.28+191754.5

(2105-T-08 [PI 反保]:

特異な突発天体MASTER OT J030227.28+191754.5のフォローアップ観測)



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VSNET collaboration
OISTER collaboration
Tomo-e collaboration

MASTER OT J030227.28+191754.5

A possible optical counterpart of IceCube neutrino event?

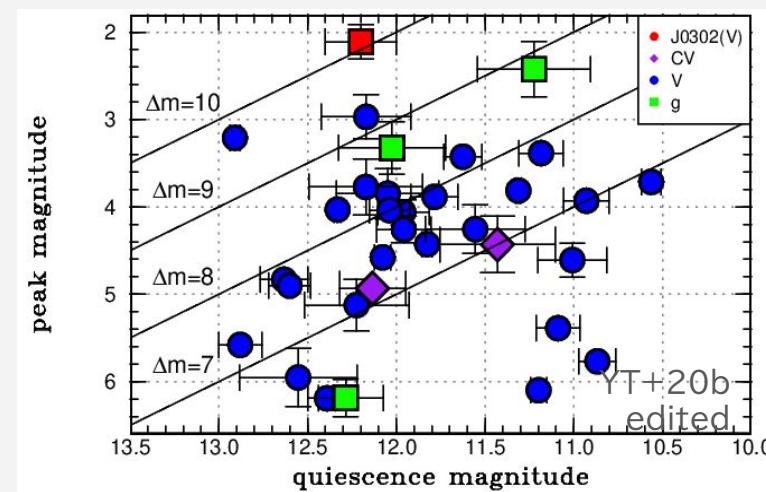
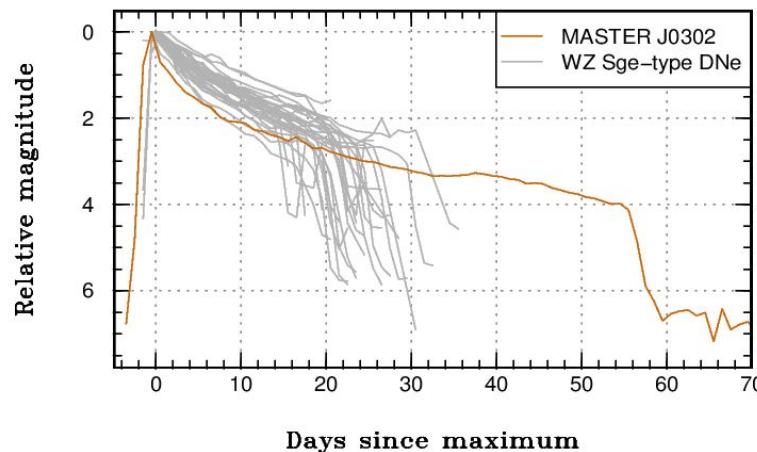
: double-peaked emission → **disk-powered & dwarf nova!**

(not likely a REAL counterpart tho)

Isogai, YT+
Atel #15074

60 d duration & 10.2 mag amplitude : Largest values in dwarf novae

⇒ How its uniqueness can be understood?



Dwarf novae & thermal instability

Primary white dwarf + low-mass star + accretion disk

→ orbital period: 80min - 10 hr

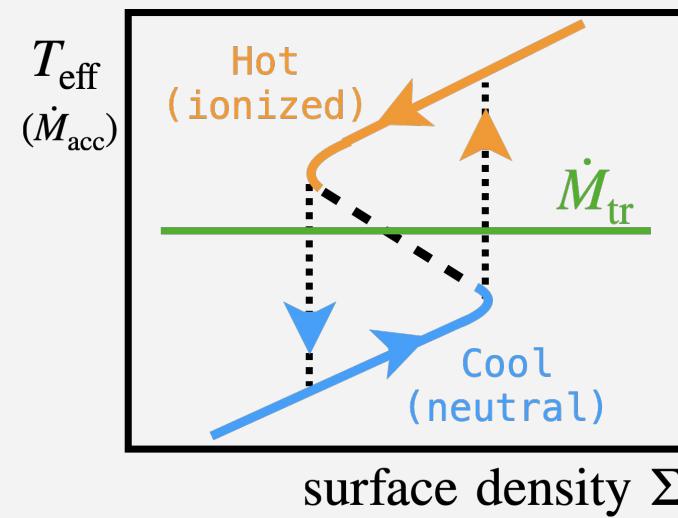
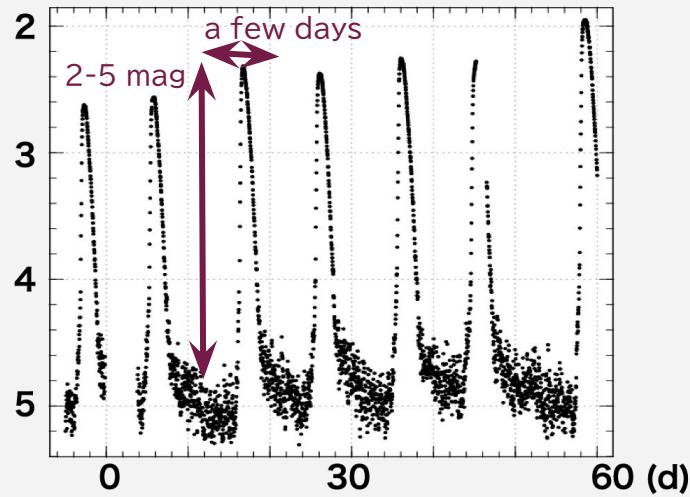
→ mass ratio: 0.03 - 1.0 ($M_{\text{Sec}}/M_{\text{WD}}$)



Recurrent outbursts by thermal instability

→ viscosity jump b/w hot-ionized & cool-neutral states

Osaki 1974
Meyer+1981

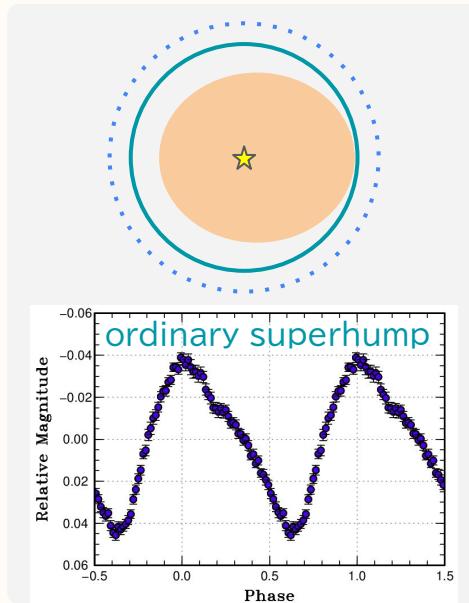
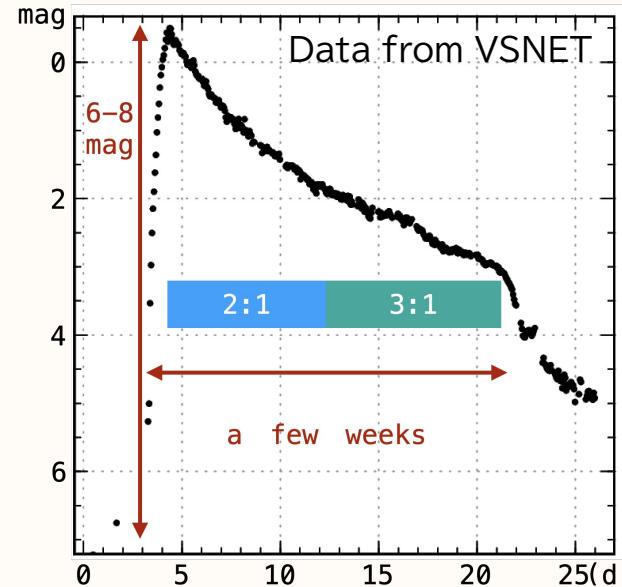
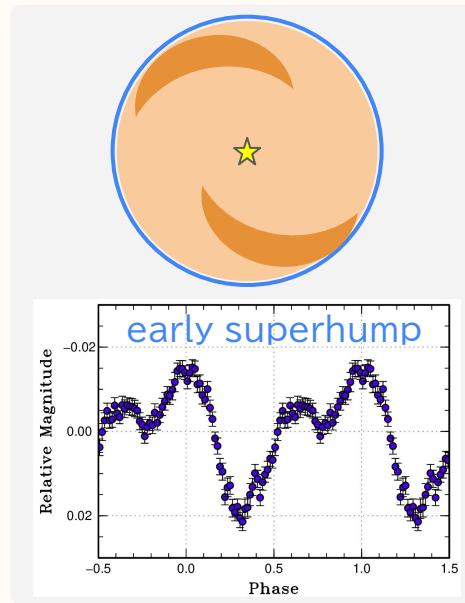


WZ Sge stars & tidal instability

Lowest mass ratio (<0.1) & shortest orbital period ($\sim 80\text{min}$)

Whitehurst 1981
Osaki+2002
Kato 2015

Resonance b/w Kepler disk & secondary \Rightarrow strong tidal dissipation
 \rightarrow energetic “superoutburst” & short-period “superhump”
 \rightarrow deformation of accretion disk: **spiral arm (2:1)** & **eccentric (3:1)**



MASTER OT J030227.28+191754.5 Observation summary

Telescopes	Wavelength	Mode	Purpose
VSNET incl. Kyoto Okujo	Optical	Time-resolved photometry	early & ordinary superhump period
OISTER - MITSuME (x3) - SaCRA - Kanata - Nayuta	Optical~IR	Multi-color photometry	color evolution, SED analysis, early superhump mapping
Seimei / KOOLS	VPH-blue VPH683/495	R~500 R~2000	Line species / profile evolution Doppler tomography
Tomo-e	Optical (clear)	2 Hz snap + time-resolve	Outburst profile Short-time variability
NICER	X-ray		SED, short-time variability To be analyzed by Kimura-san

Light curve & superhumps

MASTER OT J030227.28+191754.5

: 10.2 mag amplitude & 60-d duration !

→ largest in DNe

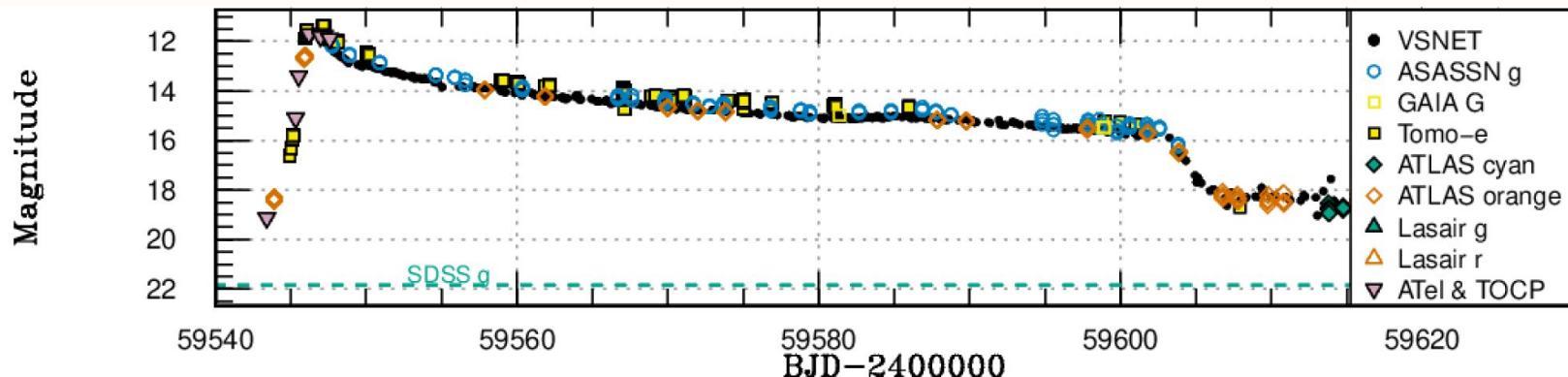
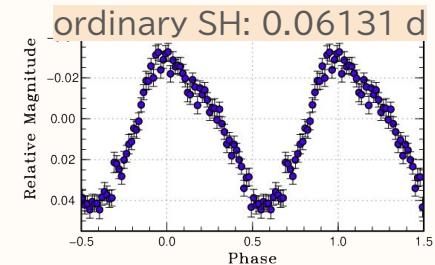
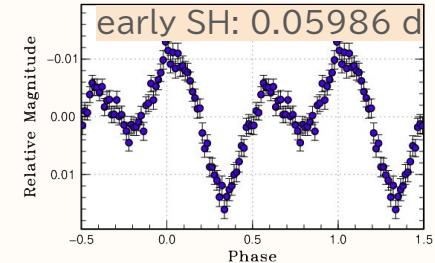
⇒ how its uniqueness can be understood?

Early & ordinary superhumps

→ WZ Sge star

No historical record of outbursts

→ outburst cycle > 10 yrs

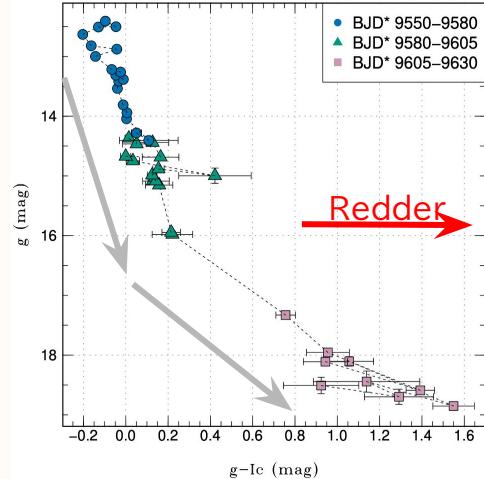
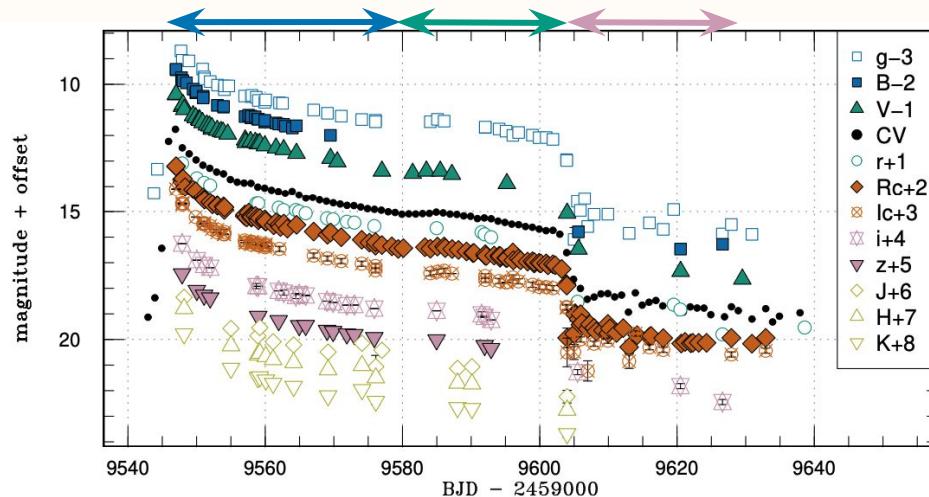


Multi-color observations

Optical-IR LCs follow V-band

Color temperature: outer disk emission

- 13000 K around peak
- 10000 K in later phase of outburst
- 6000 K after rapid decline
- : consistent w/ other DNe e.g., Shugarov+2022



Intro.

Light curve

Spectra

Discus.

Summary

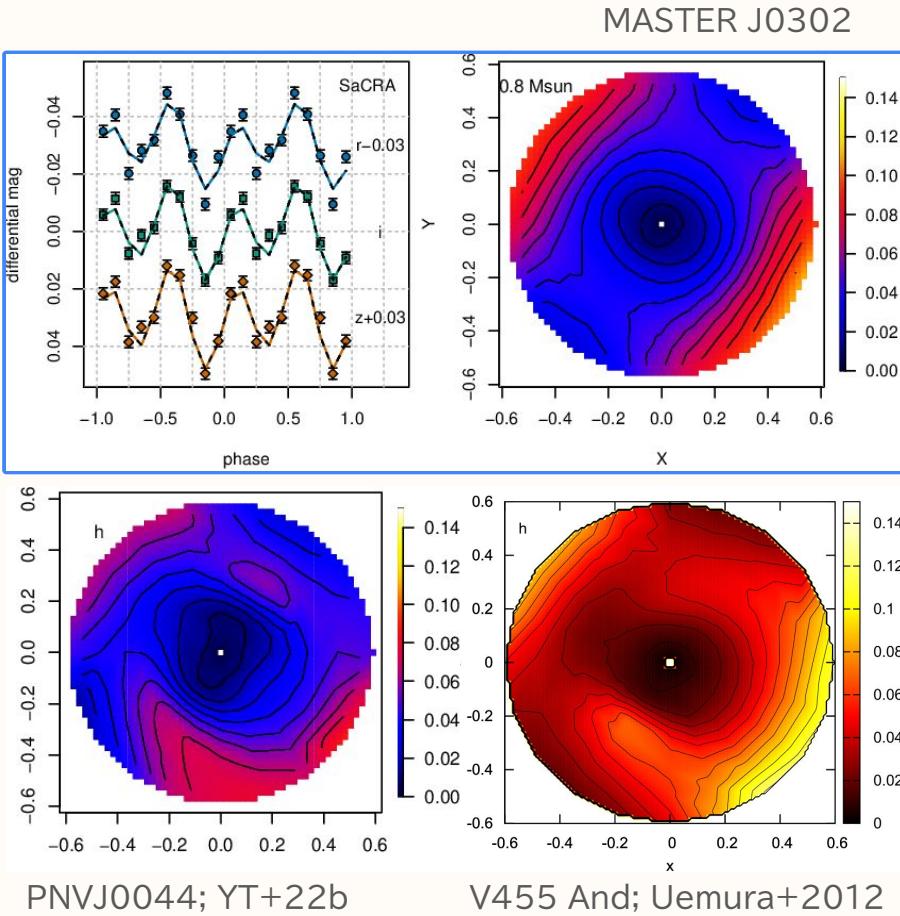
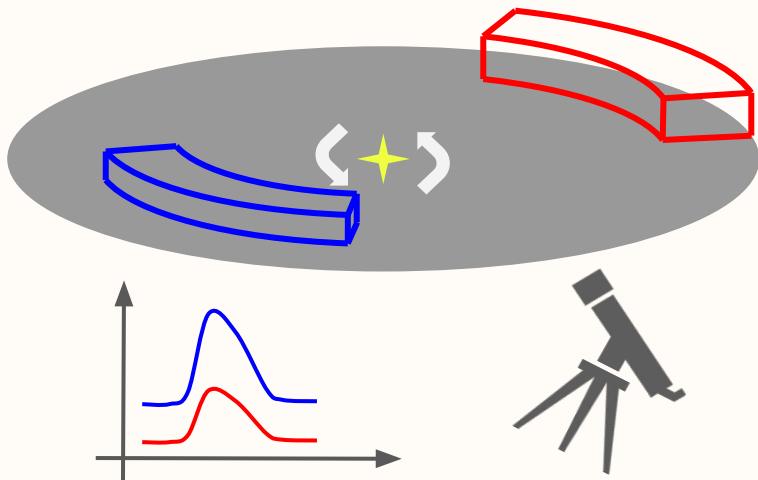
Early superhump mapping

Non axisymmetric accretion disk
: orbital rotation + self-occultation

Early SH profile
⇒ disk-height structure

Uemura+2012

MITSuME & MuSaSHI



MASTER J0302 among WZ Sge stars

Orbital period & mass ratio from superhump

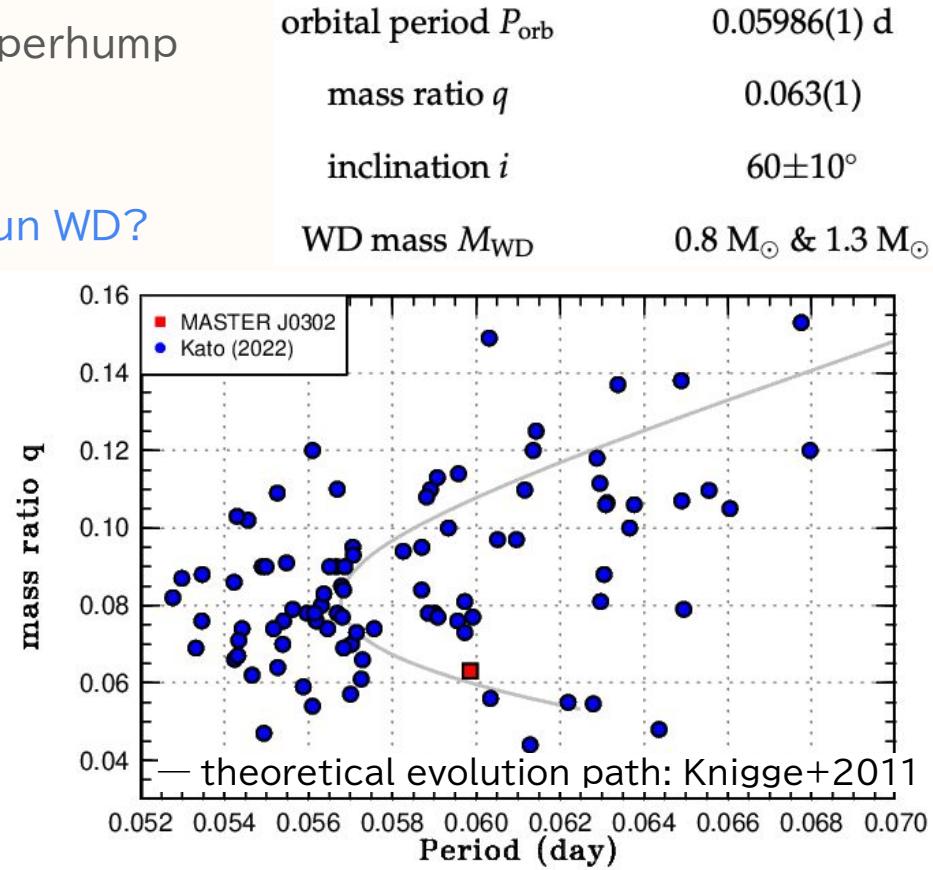
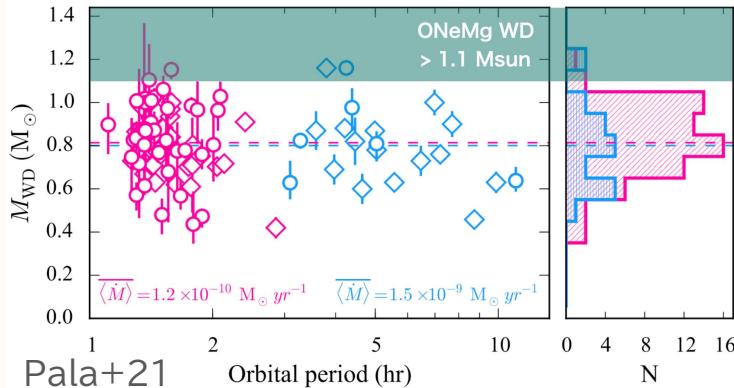
: typical as WZ Sge stars

: standard evolution?

From X-rays, host an ONe & 1.3 Msun WD?

\Leftrightarrow usually 0.8 Msun WD

: evolution channel is
an open question



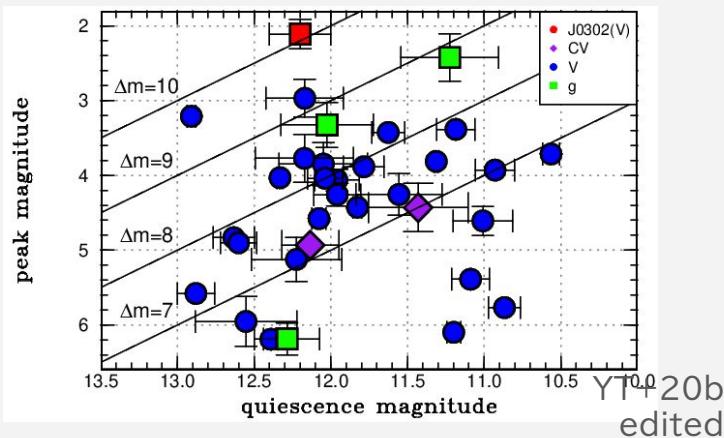
MASTER J0302 as an unprecedented DN

① Bright absolute magnitude

~2.1 absolute mag at outburst peak
 \Leftrightarrow 3-6 mag

Only -0.35 mag by 0.8 \rightarrow 1.3 M_{Sun} WD
 Warner 1987

10²⁰ g/s accretion rate from α disk
 \Rightarrow x100 of typical WZ Sge stars!



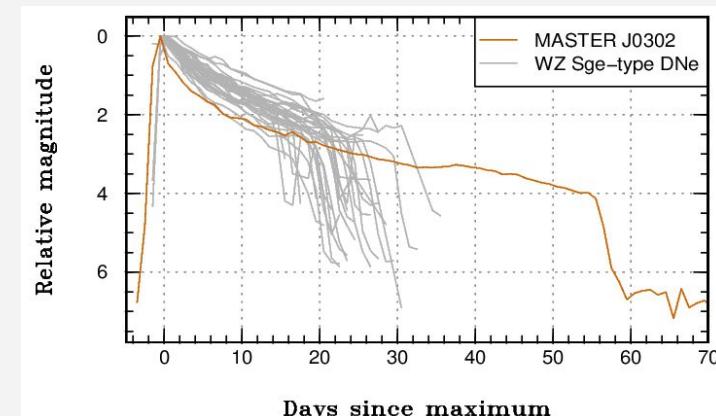
② Long duration

60-d duration in MASTER J0302
 \Leftrightarrow 20-30 d

Duration \sim accreted mass in outburst

$$M_{\text{disk,max}} \propto \alpha_{\text{cool}}^{-0.86} \times M_{\text{WD}}^{0.65}$$

disk mass viscosity WD mass



MASTER J0302: the most energetic dwarf nova outburst ever

Intro.

Light
curve

Spectra

Discus.

Summary

- Large amplitude of >10 mag and long duration of 60 d.
⇒ largest values in dwarf nova outbursts
- Early+ordinary superhumps & double-peaked lines detected
⇒ confirmed as a WZ Sge-type dwarf nova
- Orbital period & mass ratio in normal range of WZ Sge-type dwarf novae
⇐ BUT can harbor a ONe massive WD in system?
- Its peculiarity (amplitude, duration, wind feature) can be explained
as a WZ Sge-type dwarf nova in extreme conditions