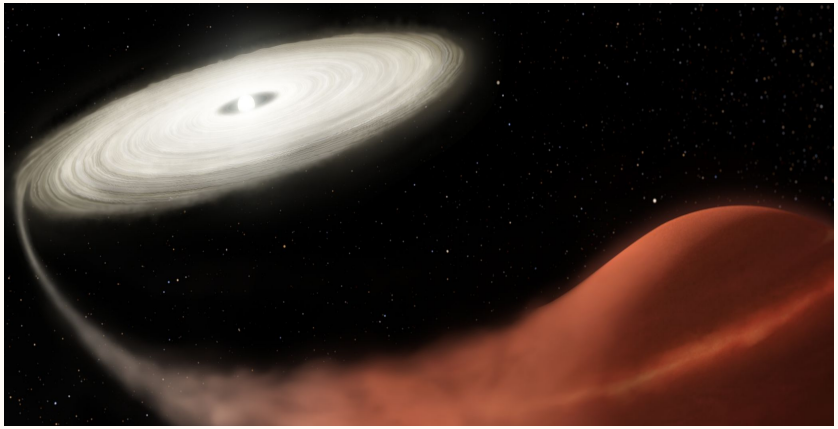
矮新星アウトバースト

MASTER OT J030227.28+191754.5

（YT+submitted to PASJ）



Y. Tampo（Kyoto U. D3）

VSNET collaboration
OISTER collaboration
Tomo-e collaboration

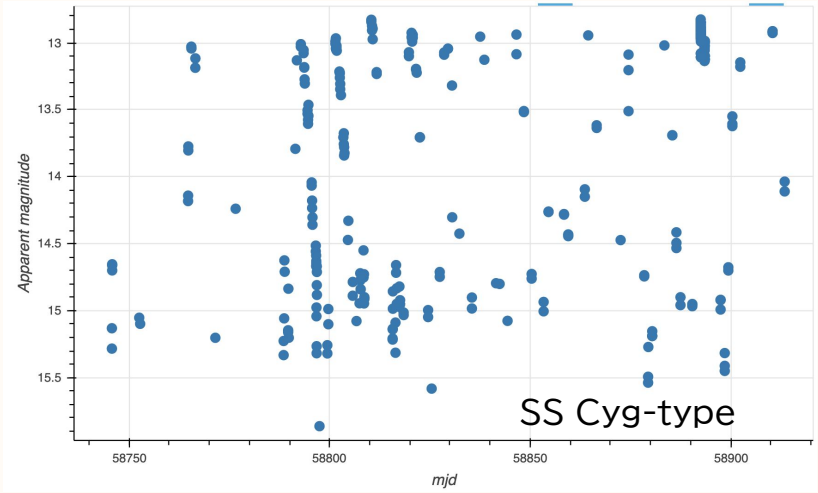
＋　Kimura+2023 ApJ accepted
（on X-ray observations）

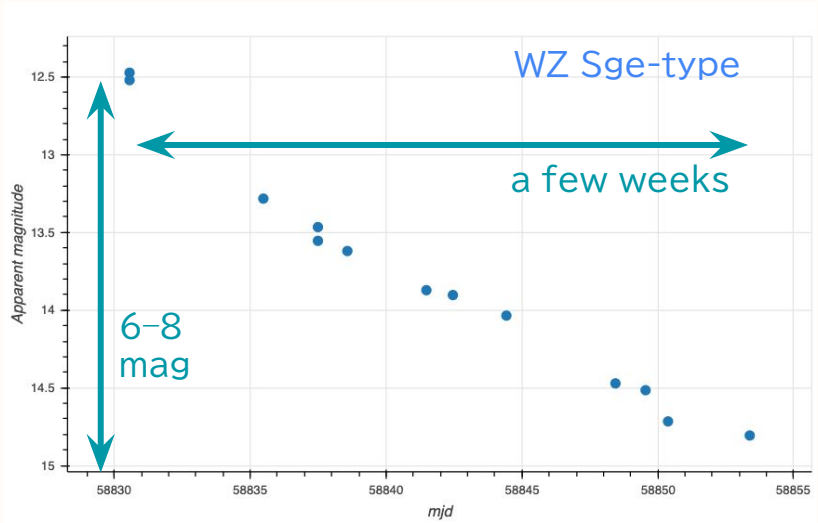
Dwarf novae

Primary white dwarf + lower mass star
& accretion disk around WD

Orbital period: 0.05 - 1 d

Some subtypes
: amplitude/duration/frequency





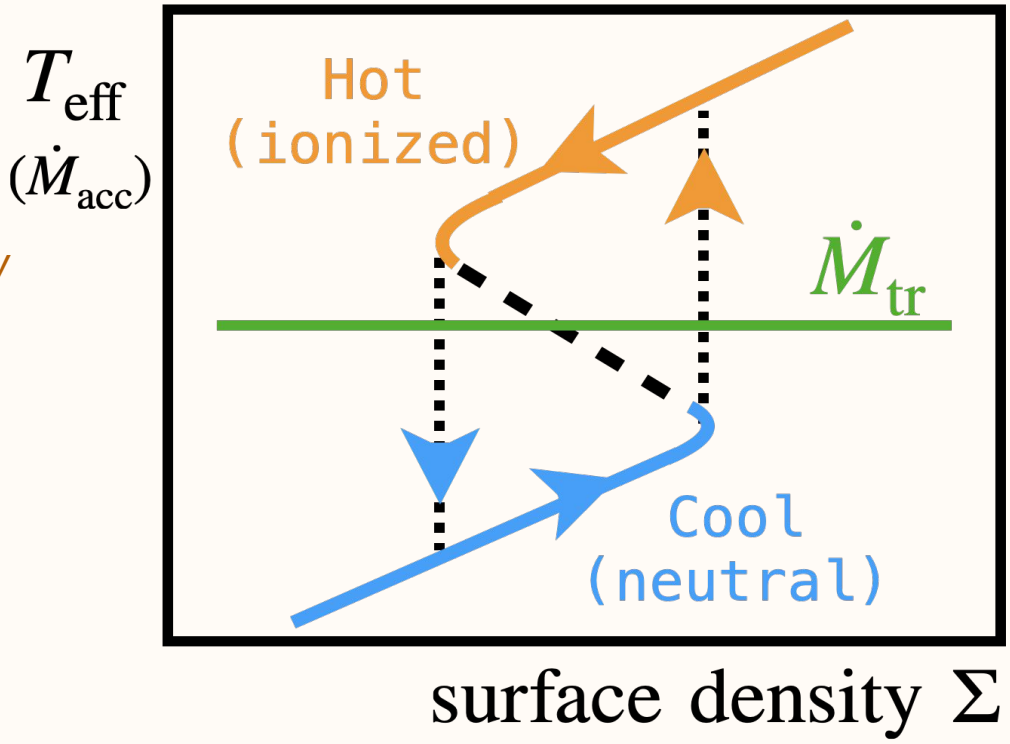
Thermal instability

Gravitational energy in disk

Balance b/w
- viscosity heating
- radiation cooling

✔ ionized, hot, & high viscosity
✔ neutral, cool & low viscosity

c.f. Osaki 1974, Meyer+1981

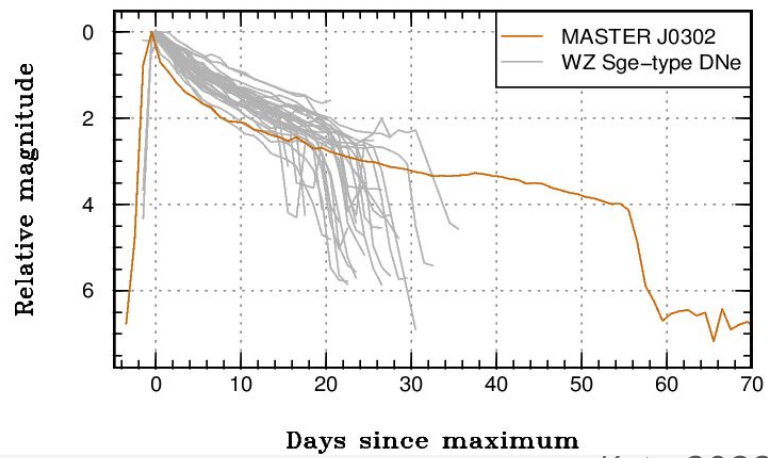


MASTER OT J030227.28+191754.5

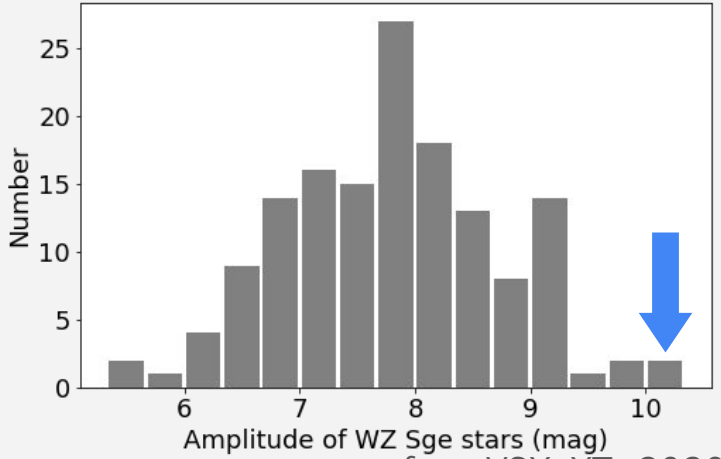
A possible optical counterpart of IceCube neutrino event (Nov. 2021)?
: double-peaked emission by Seimei tel.
→ disk-powered & dwarf nova!

Isogai, YT+
Atel #15074

60 d duration & 10.2 mag amplitude
: Largest valules in dwarf novae
⇒ How its uniqueness can be understood in DN model?



Kato 2022



from VSX, YT+2020b

Observation summary

Telescopes	Wavelength	Mode	Purpose
VSNET incl. Kyoto Okujo	Optical	Time-resolved photometry	early & ordinary superhump period
Tomo-e	Optical (clear)	2 Hz snap + time-resolve	Outburst profile Short-time variability
NICER+NuSTAR	X-ray		SED, short-time variability Analyzed by Kimura-san
OISTER	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

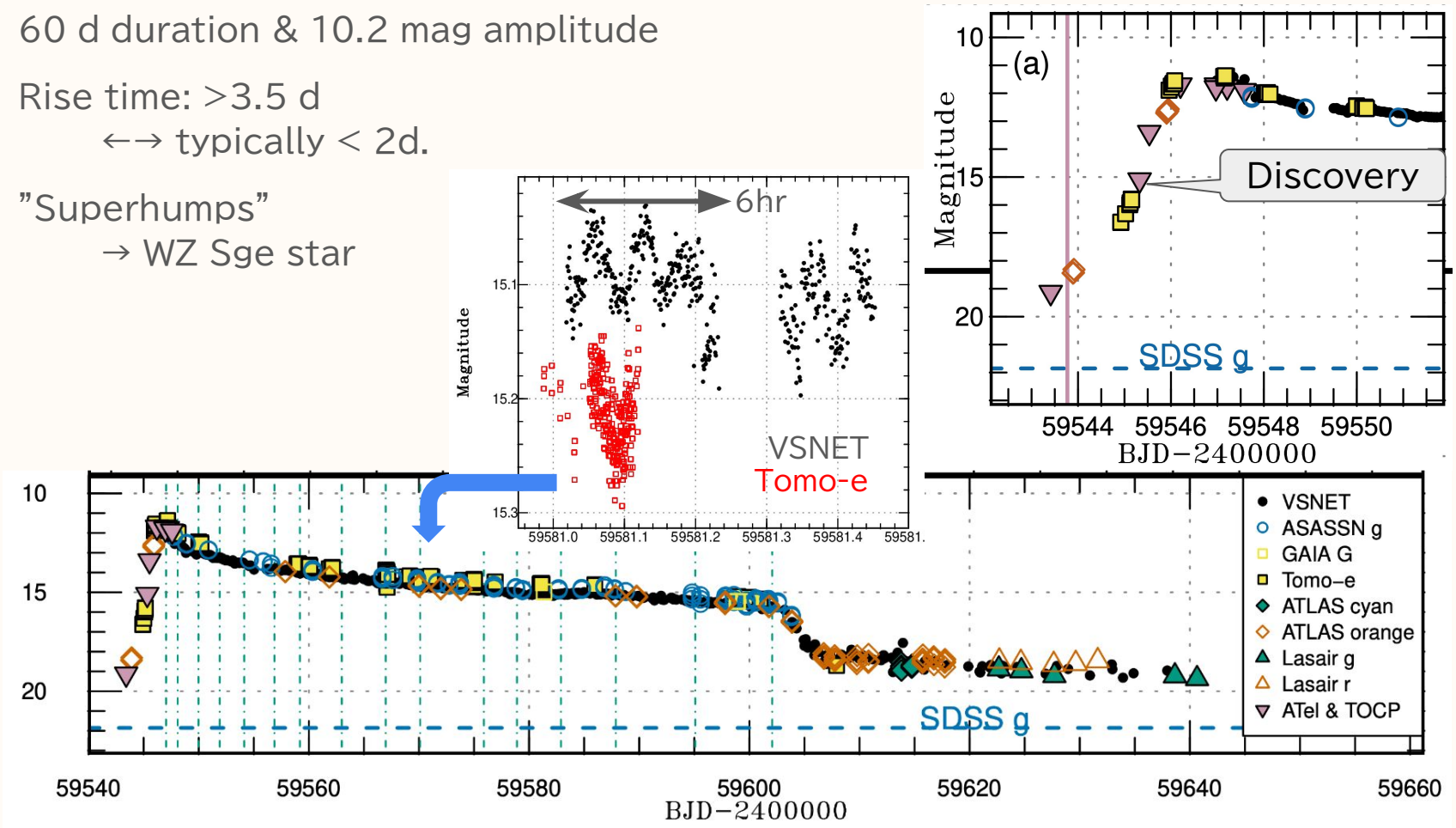
Thx to Masaomi-san & Tominaga-san for Tomo-e data!

Light curve

60 d duration & 10.2 mag amplitude

Rise time: >3.5 d
←→ typically < 2d.

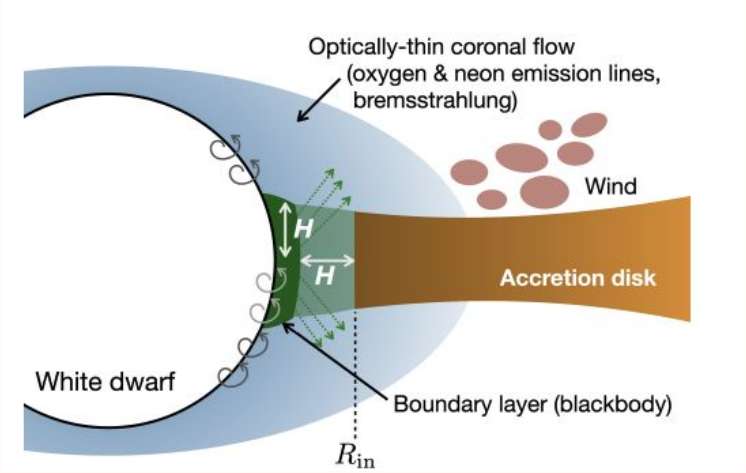
”Superhumps”
→ WZ Sge star



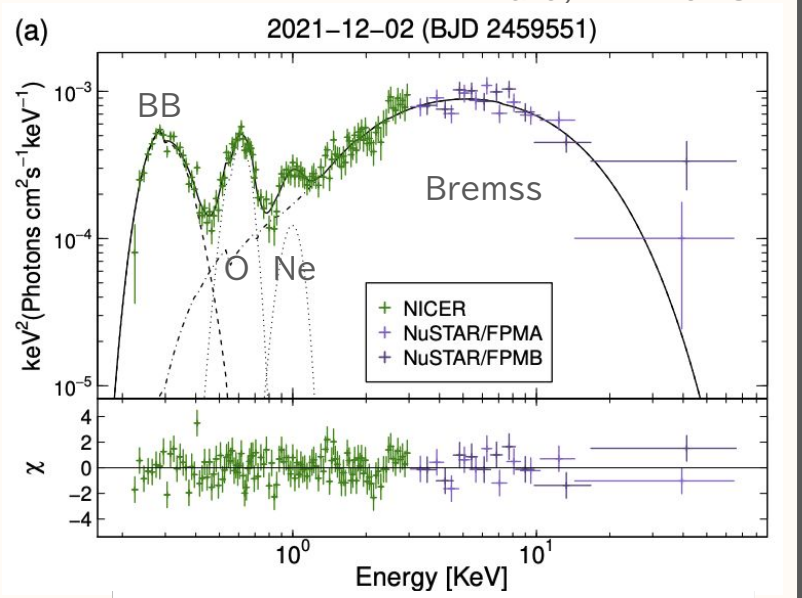
X-ray observations - spectra

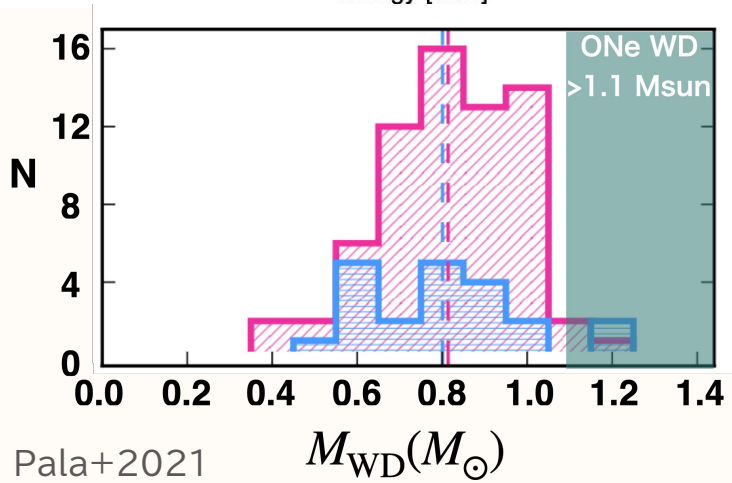
Oxygen + neon emission lines
⇒ ONe WD?

X-ray blackbody
Temperature: 30 eV
Luminosity: 1.5 x 10^{34} erg/s
⇒ (2.9±1.1) x 10^{8} cm
⇒ 1.15–1.34 Msun



Kimura, YT+2023





Pala+2021

Peculiarities of MASTER J0302 I

10.2 mag amplitude
: quiescence ~ 12.2 mag
: maximum ~ 2.1 mag

Disk@outburst maximum
== standard disk

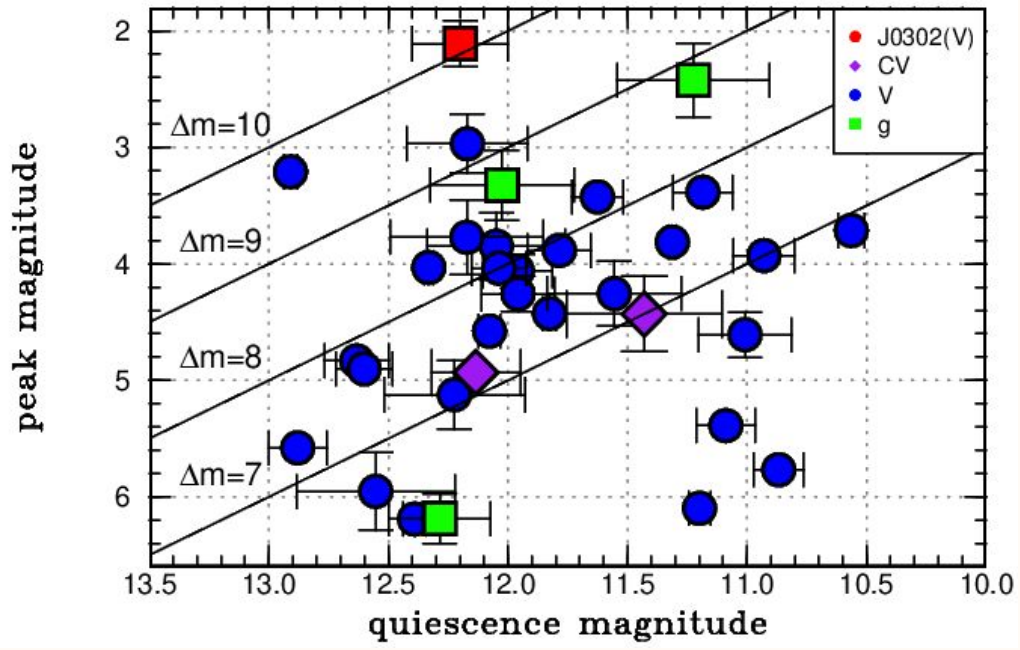
Mock WZ Sge : 1.5 x 10^{18} g/s
(Mv ~ 4 mag)
J0302 : ~1.2 x 10^{20} g/s

$$T_{\rm eff} = \left[\frac{3GM_{\rm WD}\dot{M}_{\rm acc}}{8\pi\sigma r^3}\left(1-\sqrt{\frac{r_{\rm in}}{r}}\right)\right]^{1/4}$$

$$B_\nu(r) = \frac{2h}{c^2}\frac{\nu^3}{\exp\left[h\nu/kT_{\rm eff}(r)\right]-1}$$

$$S_\nu = \frac{\cos i}{D^2}\int_{R_{\rm WD}}^{r_{2:1}} B_\nu(r)2\pi r dr$$

YT+2020b edited



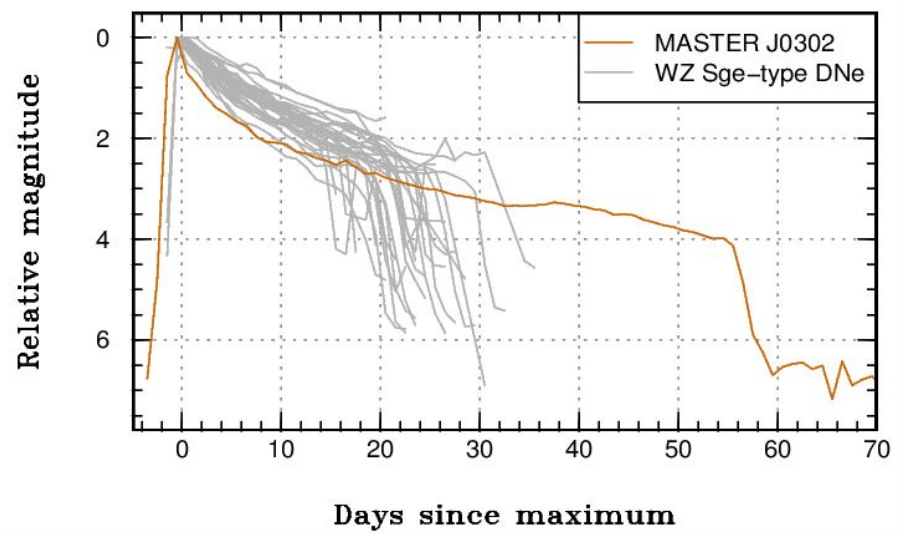
Peculiarities of MASTER J0302 II

Long outburst duration
⇒ large accreted mass in outburst
⇒ large disk mass at the onset

Disk mass NOT to trigger an outburst

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

Warner 1995



MASTER J0302 outburst scenario

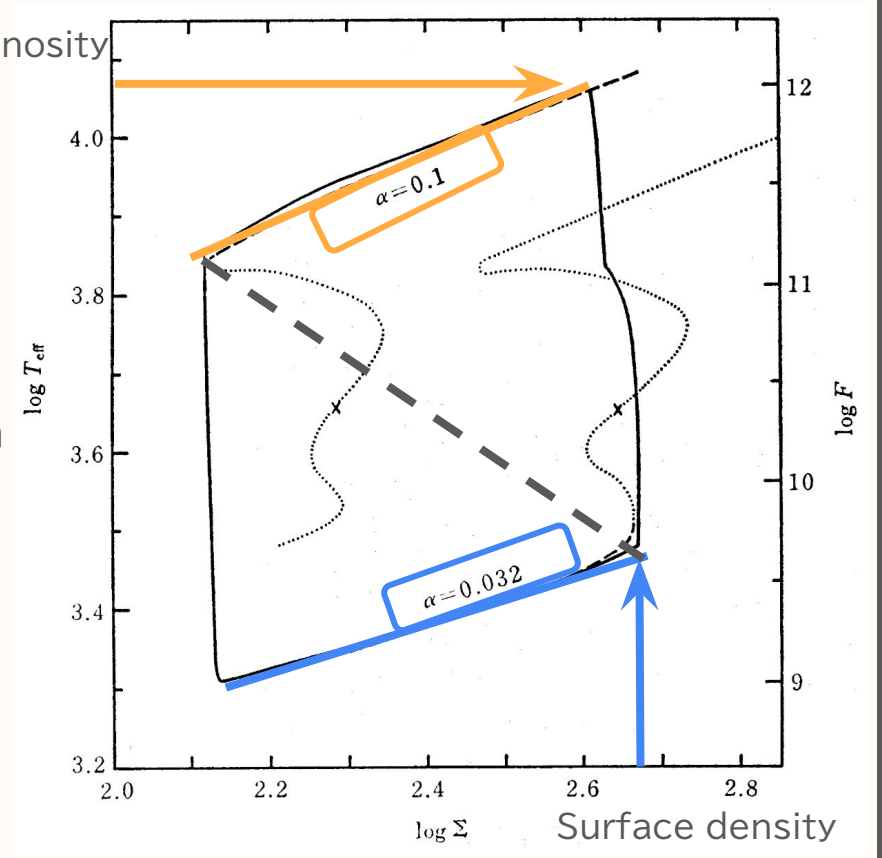
To explain MASTER J0302 outburst…

1) large disk mass
2) high accretion rate

Low quiescence viscosity
can be a clue

1. low quiescence viscosity
2. larger disk mass
3. larger accretion rate at hot branch

Mineshige&Osaki 1983



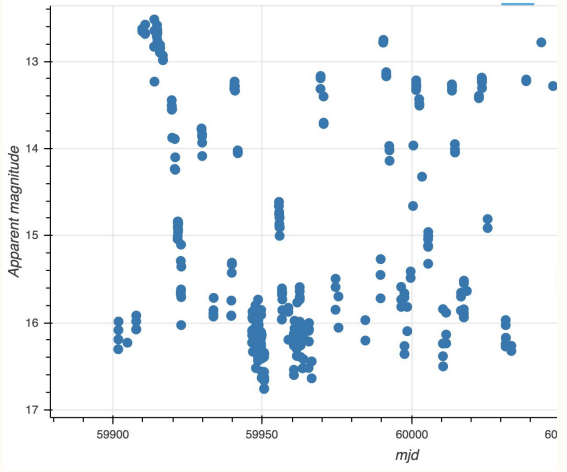
Tomo-eデータの矮新星での活用

Cons.

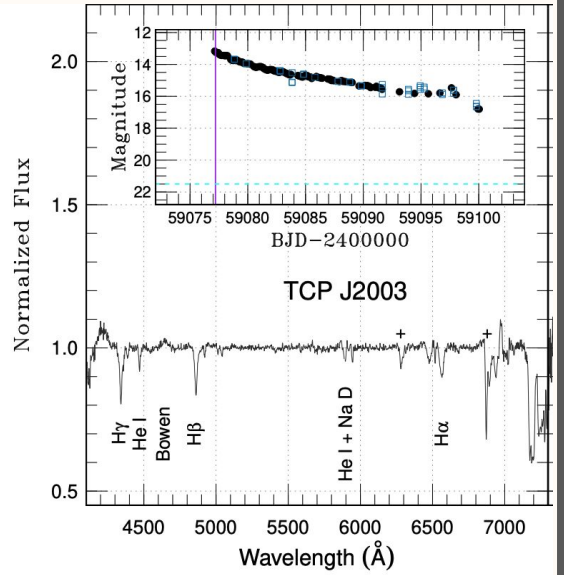
- 連続観測が必要（周期変動 → binary parameter）
  ⇒ サーベイとの相性が悪い ⇒ すみわけ
- 再帰性のある / 対応天体のある突発天体
  ⇒ “新天体”サーベイでは見逃されがち
  ⇒ 既知天体の増光モニター(が欲しい/を作ります)

Pros.

- とにかくたくさんの矮新星の光度曲線（押切くん’s talk）
  ⇒ light curveの概形を知るには十分
  ⇒ 2Hzを活かしてASAS-SN/ZTFに勝てるサイエンス？
- 木曽 – せいめいのネットワーク
  ⇒ 既知天体でもレアなアウトバーストは撮りたい
  ⇒ 撮り溜まれば論文書きます(意思)



YT+2021



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

- Based on X-ray blackbody emission + Oxygen & Neon emission line

  ⇒ dwarf nova harboring a massive ONe WD?

- Massive WD cannot explain all aspects

  ⇒ require large disk in quiescence & high accretion rate at outburst