



Transients from Double White Dwarf mergers

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The dynamic life of compact objects

- Isolated, Binaries, Cataclysmic variables
- Compact binaries
 - BNS mergers have been an area of interest in observational searches since GW170817
 - DWD mergers will be one of the major signal sources in LISA, TianQin, Taiji

What happens to WD binaries?

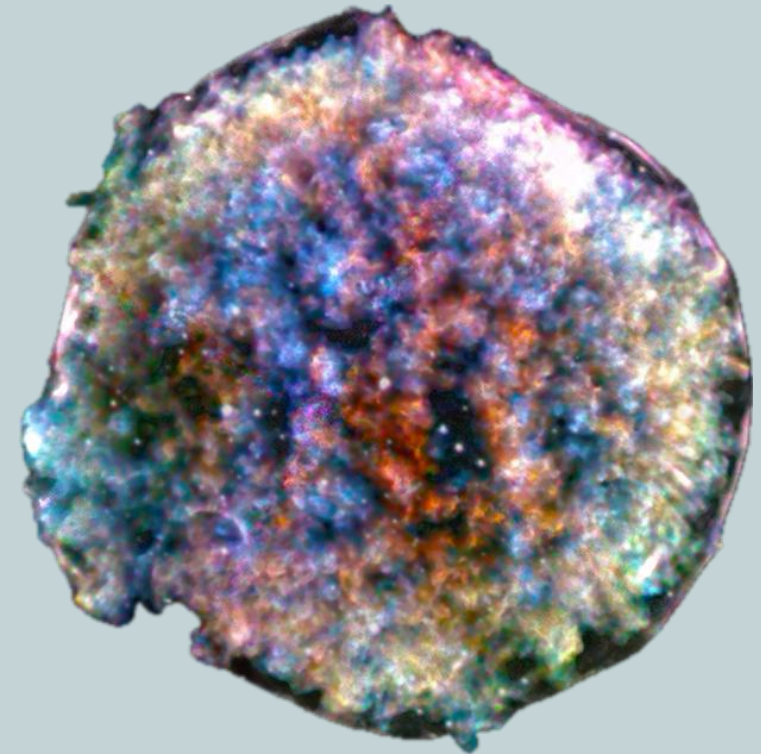
- Thermonuclear explosion – SN Ia

SNIa $\sim (2.1\text{--}2.6) \times 10^4 \text{ Gpc}^{-3} \text{ yr}^{-1}$ (Maoz-MNRAS-2018)

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DWD $\sim (5\text{--}7) \times 10^5 \text{ Gpc}^{-3} \text{ yr}^{-1}$ (Perley-ApJ-2020)

- Non-explosive outcomes?
- The case of ultra massive WDs

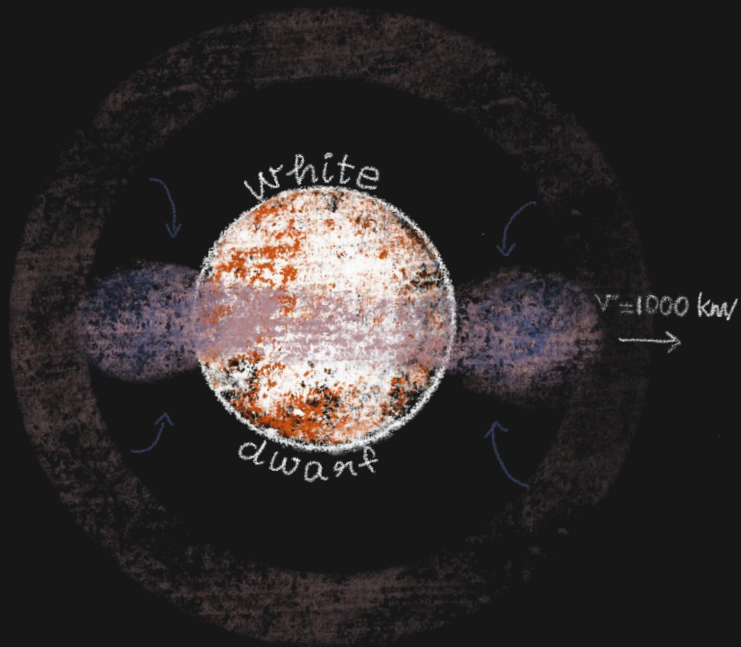


X-ray: NASA/GSFC
Optical: DSS

Energy source: $H = H_0 \left(1 + \frac{t}{t_c}\right)^{-\delta}$

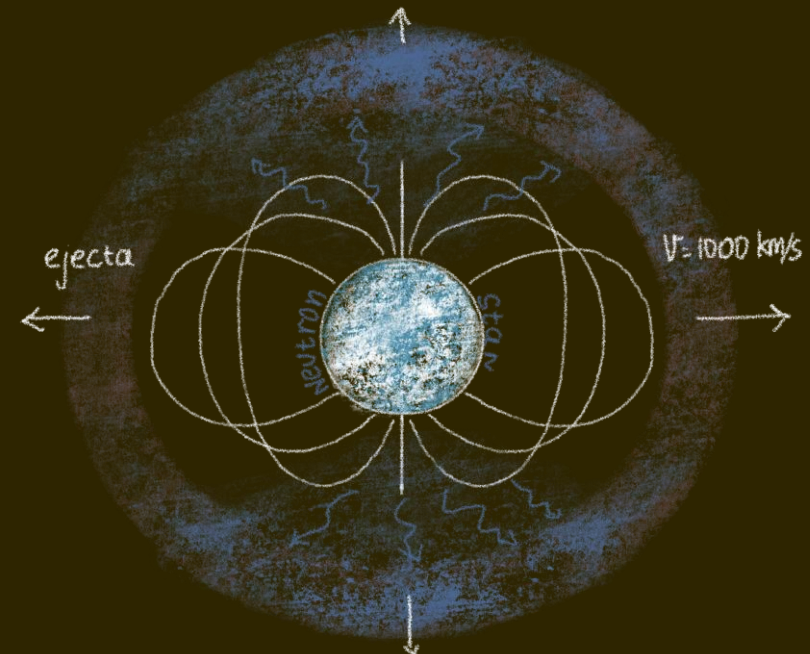
Fallback accretion - WD remnant

Sousa-ApJ-2023



Spindown radiation - NS remnant

Ridha Fathima-JHEAP-2026



Ejecta model

- Density $\rho = \rho_0 x^m t^{-3n}$
- Gray opacity $\tau = \int \kappa \rho(x, t) dx$
- Photosphere

$$R_{\text{ph}} = \begin{cases} r_N (1 - \varepsilon r_o^2)^{1/(1-m)}, & \tau < 1 \\ r_N, & \tau \geq 1 \end{cases}$$

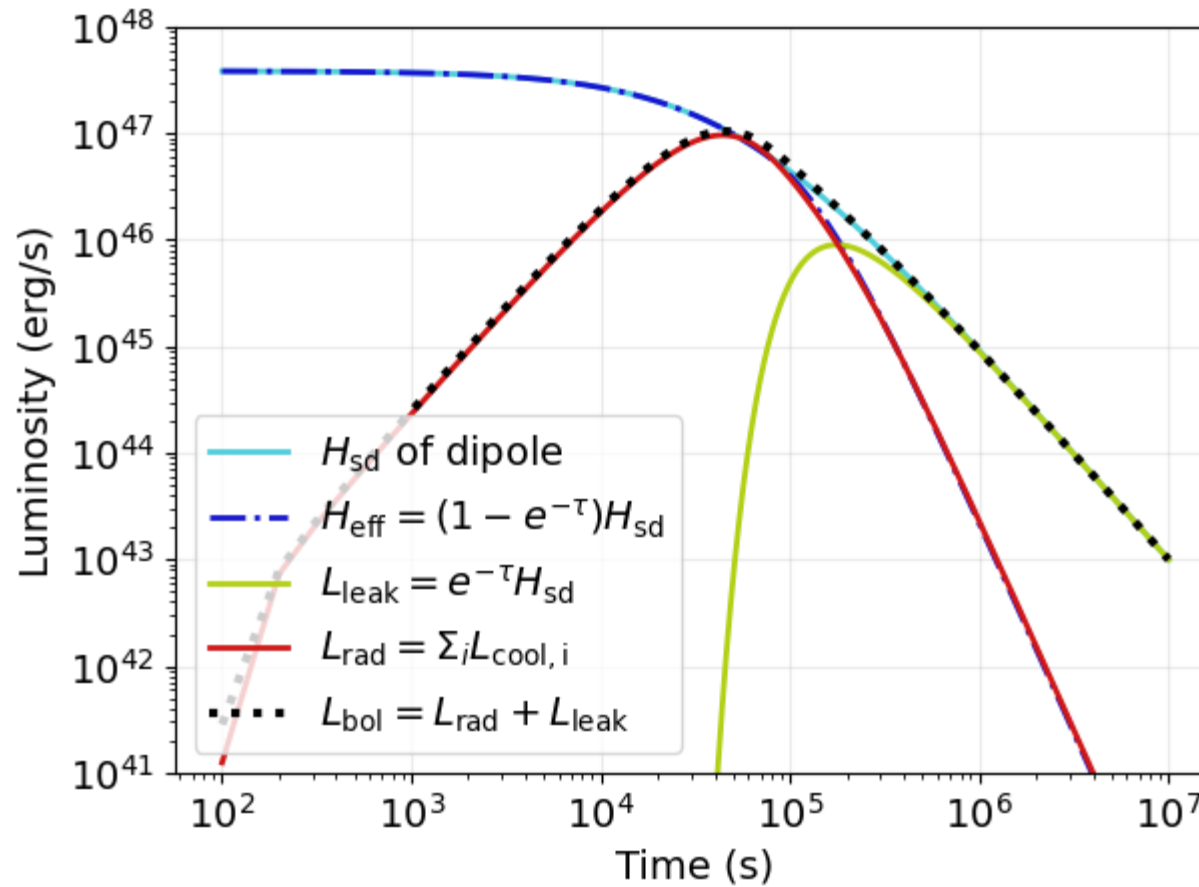
m	9
n	1
κ	0.2
$m_{\text{ej}} (M_{\odot})$	1e-3
$R_{\text{ej},0} \text{ (cm)}$	1e11
$v_{\text{ej}} \text{ (cm/s)}$	1e9

Energy equation

$$\dot{E} = (1 - e^{-\tau})H - P \dot{V} - L_{therm}$$

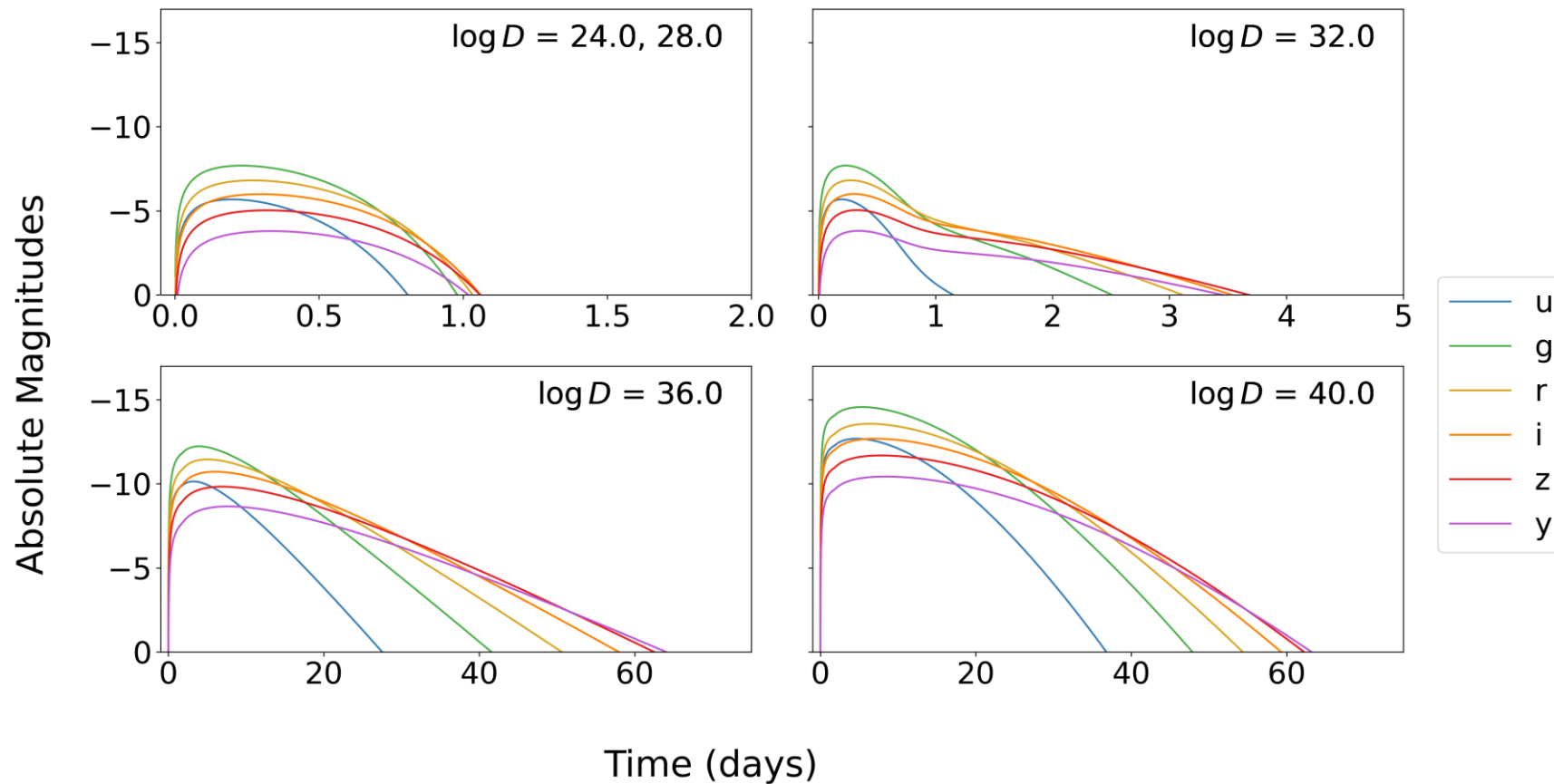

$$L_{leak} = e^{-\tau} H$$

Bolometric luminosity

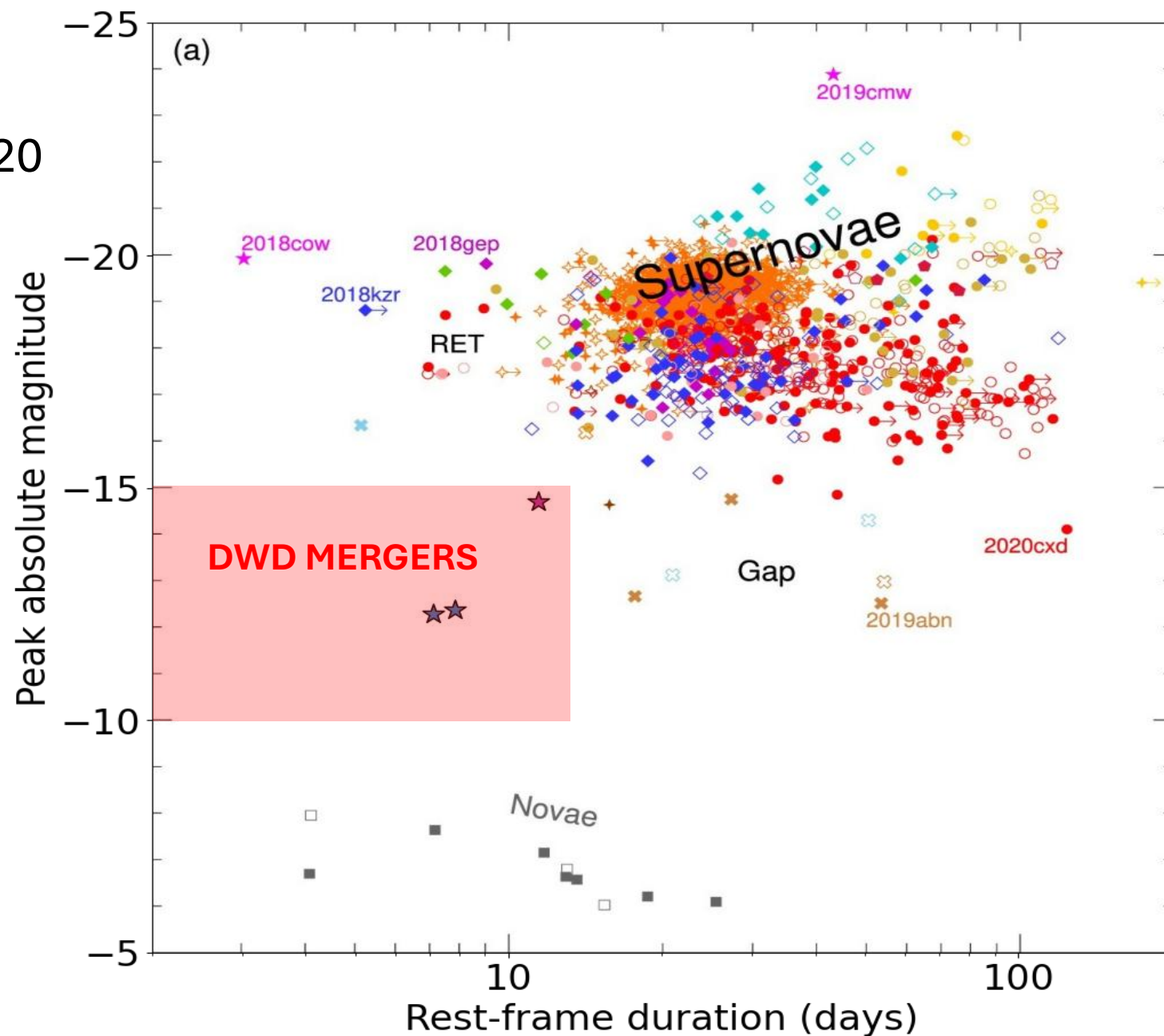


Fast, faint transients

- Peak > -15 mag
- Decay rate > 0.1 (mag/d)
- Blue at peak ($g-r \sim -1$ mag)



Adapted from
Perley-ApJ-2020



Predicting the rate

$$\log_{10} d_{max,pc} = 0.2 \times (m_{lim} - M_{cad} + 5)$$
$$N [d < d_{max}] = R_{event/Gpc/yr} \times \frac{4}{3} \pi d_{Gpc}^3$$

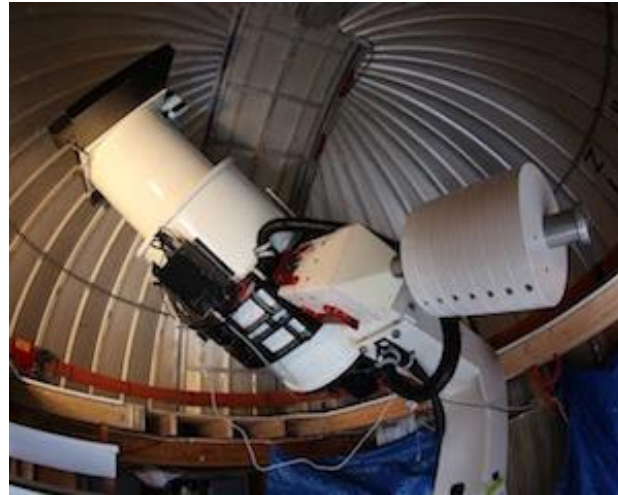
- Assuming 100% of non-explosive cases ($R_{DWD} - R_{SNIa}$) becomes a WD

$$R_{tra} = k_{rem} R_{DWD} + l_{DD} R_{SNIa}$$



ZTF/IPAC

- 10–100 yr⁻¹
in ZTF g-band
within
20–70 Mpc



ATLAS

- 100–1000 yr⁻¹
in ATLAS o-band
within
40–120 Mpc



LSST/VRO

- 100–10⁶ yr⁻¹
in LSST g-band
within
240–760 Mpc

DWD mergers can produce
detectable fast transients!



WD

