



Diversity in circumstellar environments of helium-rich explosions

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Motivation

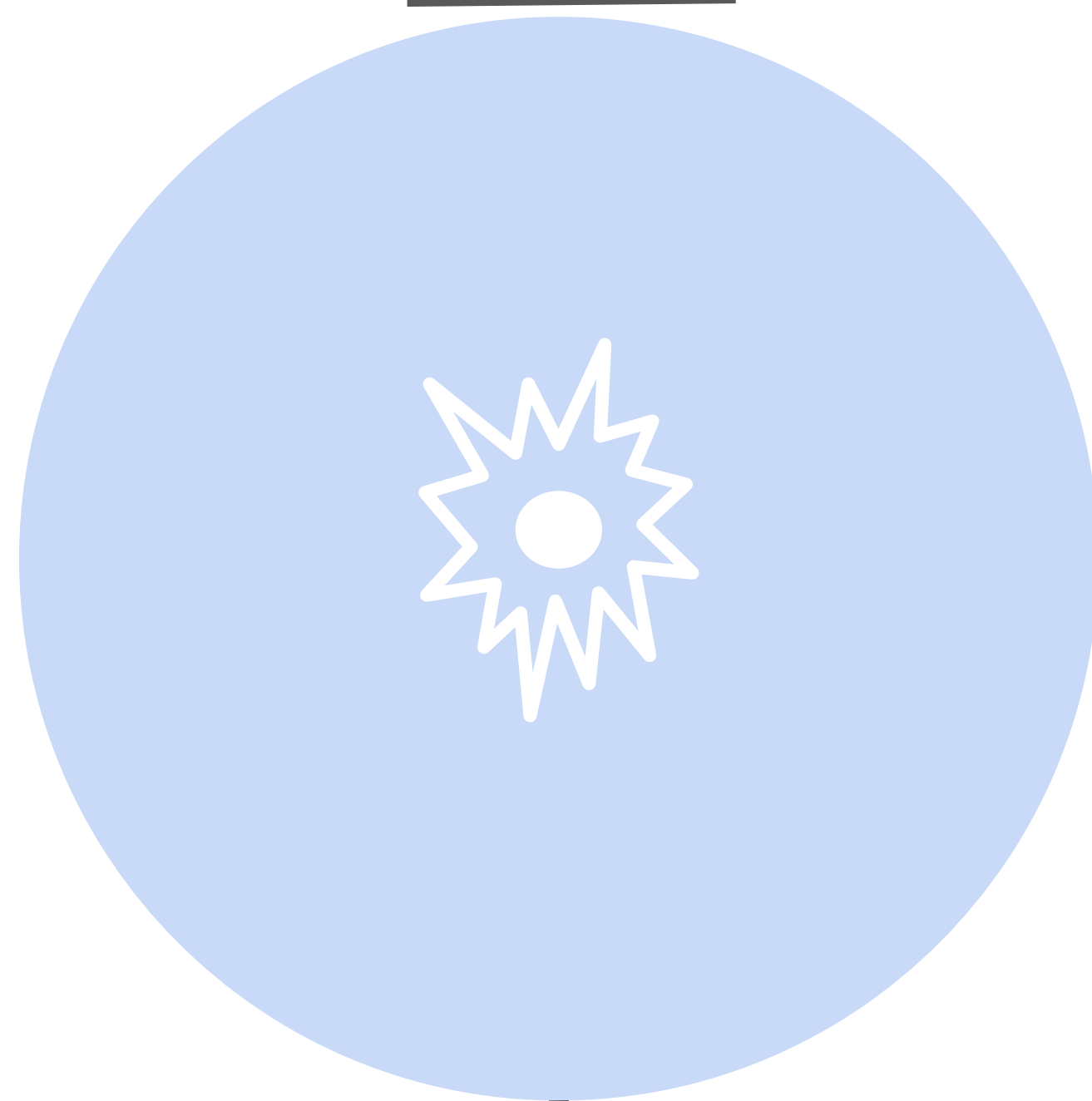
- ★ While discoveries of stripped-envelope supernovae and exotic variants are increasing, the **timing and magnitude of stripping/mass loss are not well understood**
- ★ Radio and X-ray observations can uniquely probe the circumstellar environment through views of shocks from ejecta-circumstellar medium (CSM) interaction– **in particular when the mass loss is not intensive enough to generate observable optical signatures**

SN Ib → II_n 2019yvr

Baer-Way+ (in prep)

10-100 yrs pre-explosion

1-10 yrs pre-explosion



- ★ Type Ib supernova (strong helium P Cygni) at explosion that **transitioned to a type II_n**– showed hydrogen emission lines from circumstellar shock
- ★ Radio and X-ray observations from 30-1600 days reveal CSM formed from **constant mass-loss based on radio synchrotron model/X-ray detection at early times**
- ★ Mass-loss rate consistent with other SN Ib–No **higher-density CSM unlike counterpart SN 2014C**
- ★ Consistent with **mass loss due to a binary companion–RLOF**

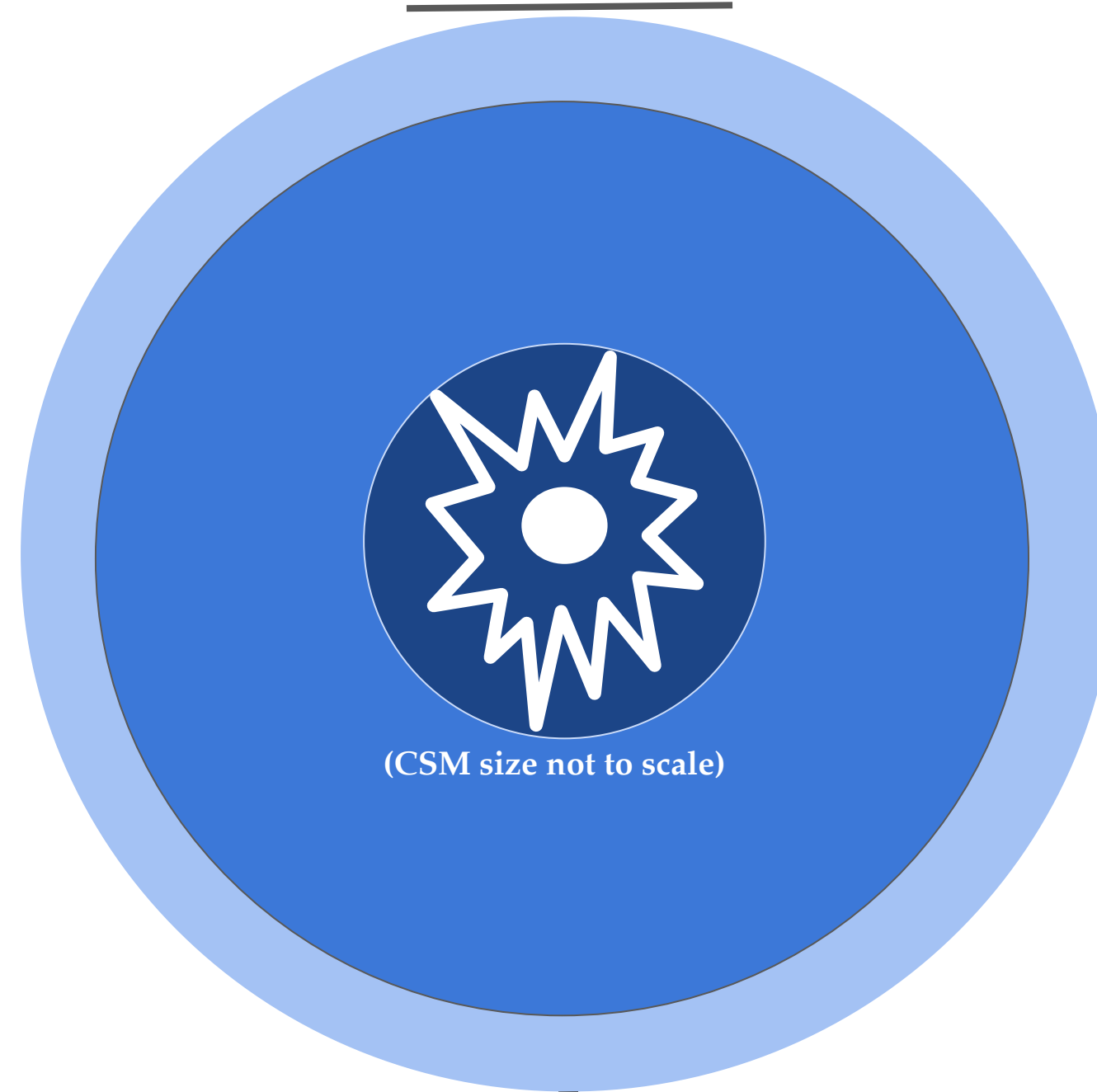
SN Ibn 2023fyq



Baer-Way+2025

10-100 yrs pre-explosion

1-10 yrs pre-explosion



- ★ Type Ibn (narrow helium in emission) supernova with **pre-explosion optical outbursts**
- ★ **First Radio detection of SN Ibn**
- ★ Best-fit Synchrotron+Free-free model implies mass-loss at rate **~0.005 M_⊙/yr at ~200 days post-explosion–lower than early optical estimates from ~0-20 days**
- ★ X-ray non-detections confirm **declining CSM density**
- ★ CSM at decreasing densities—**repeated mass ejections or increasing mass loss on the way to a merger?**

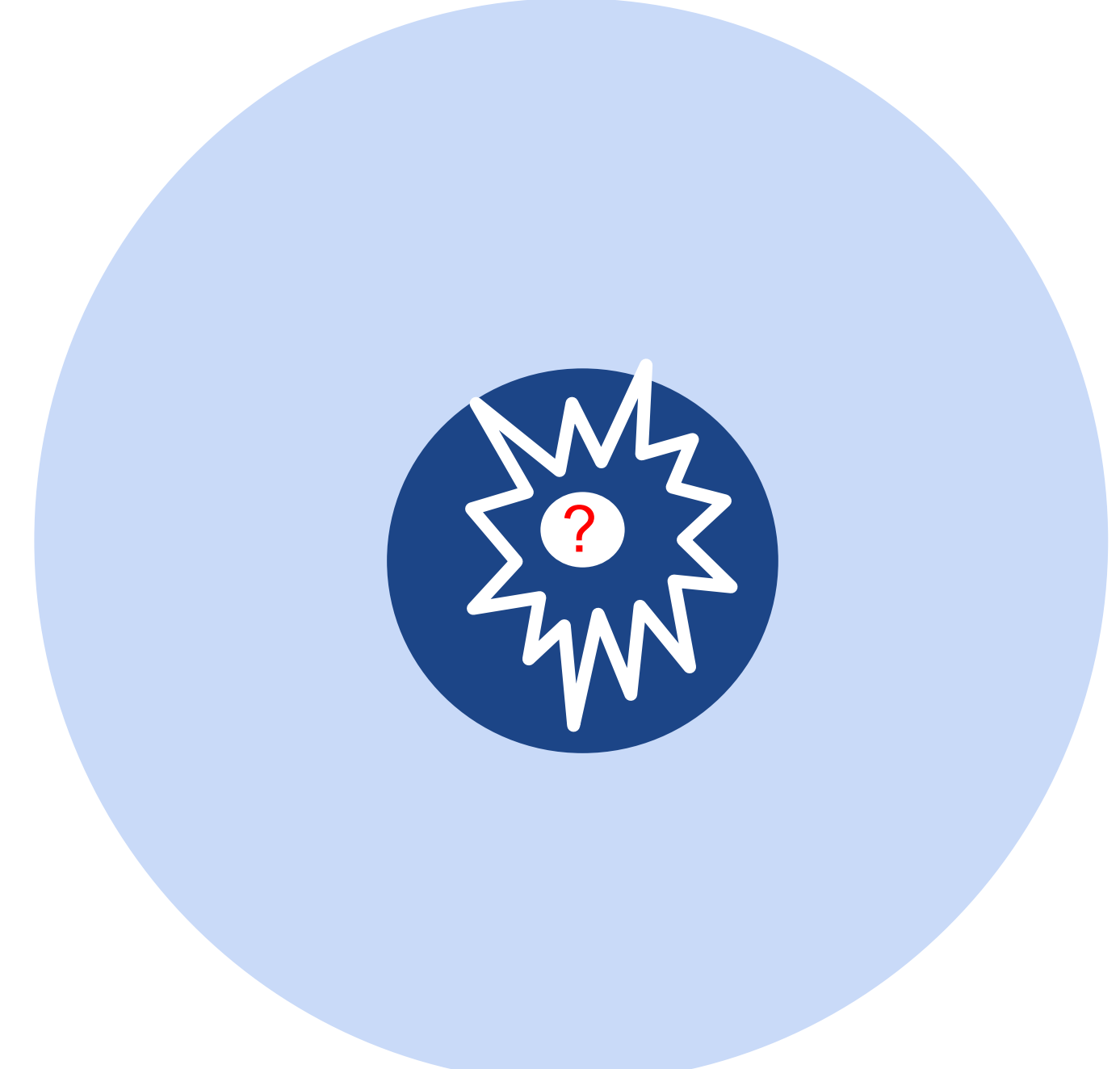
CaST-Ib 2025coe



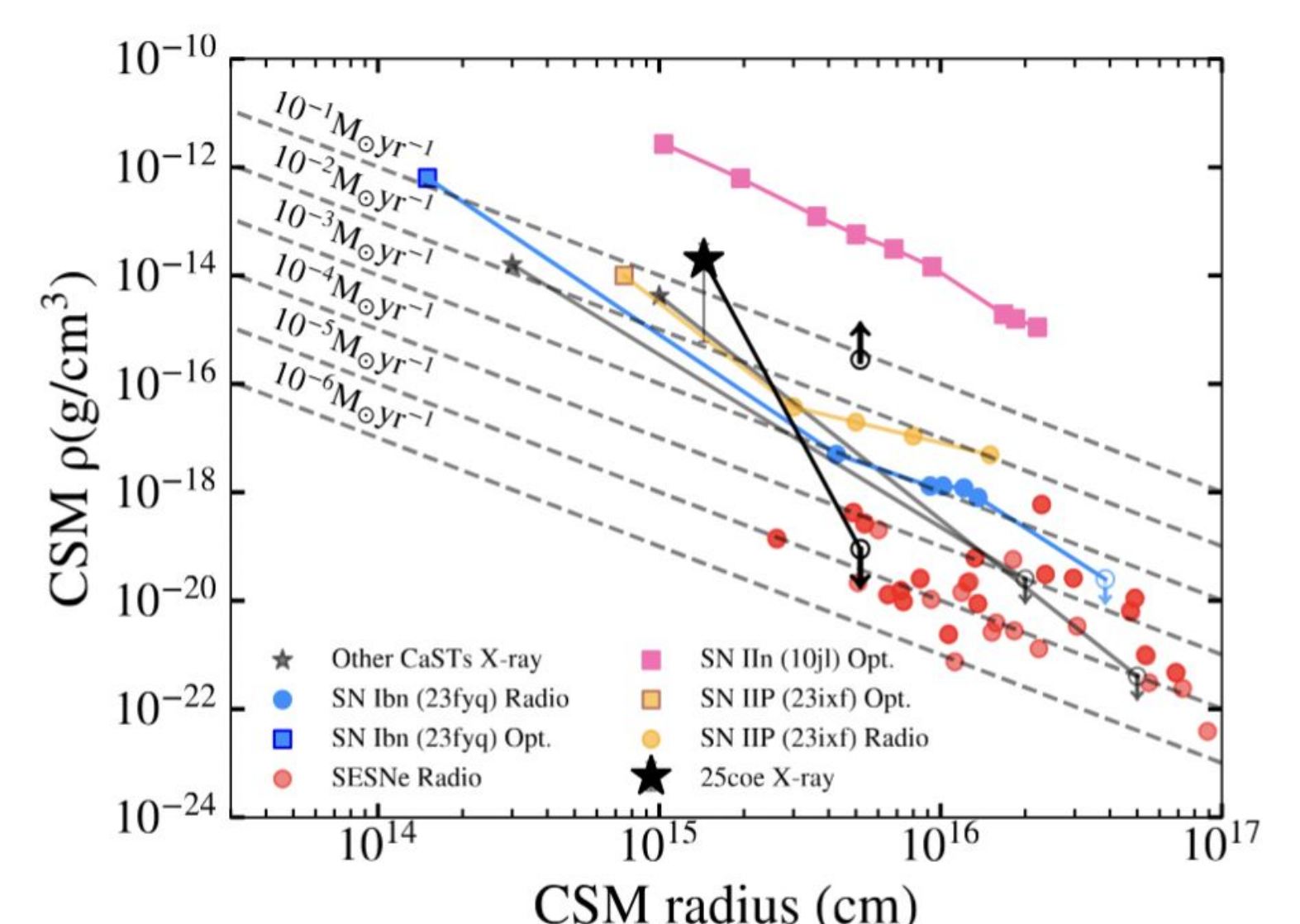
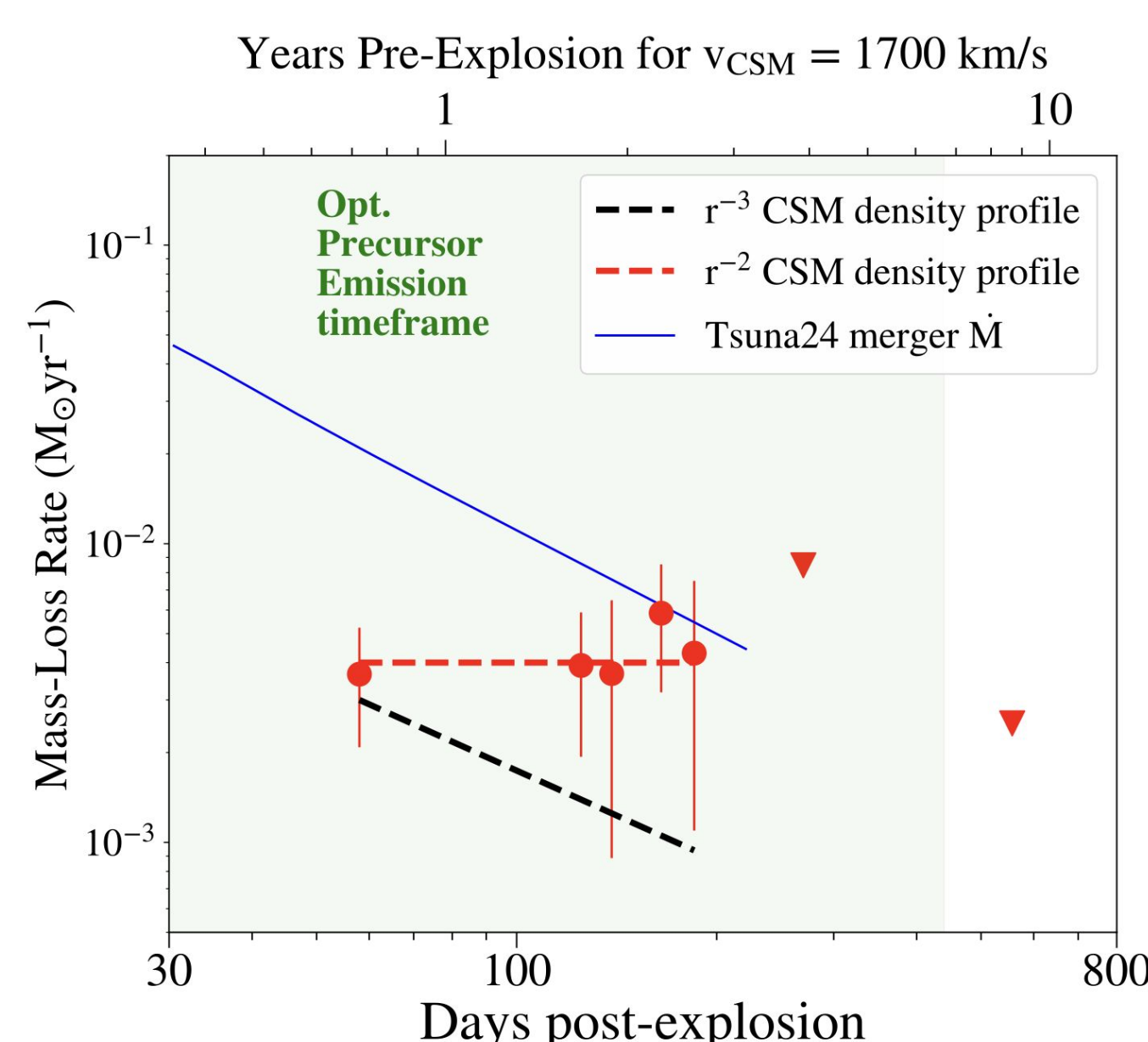
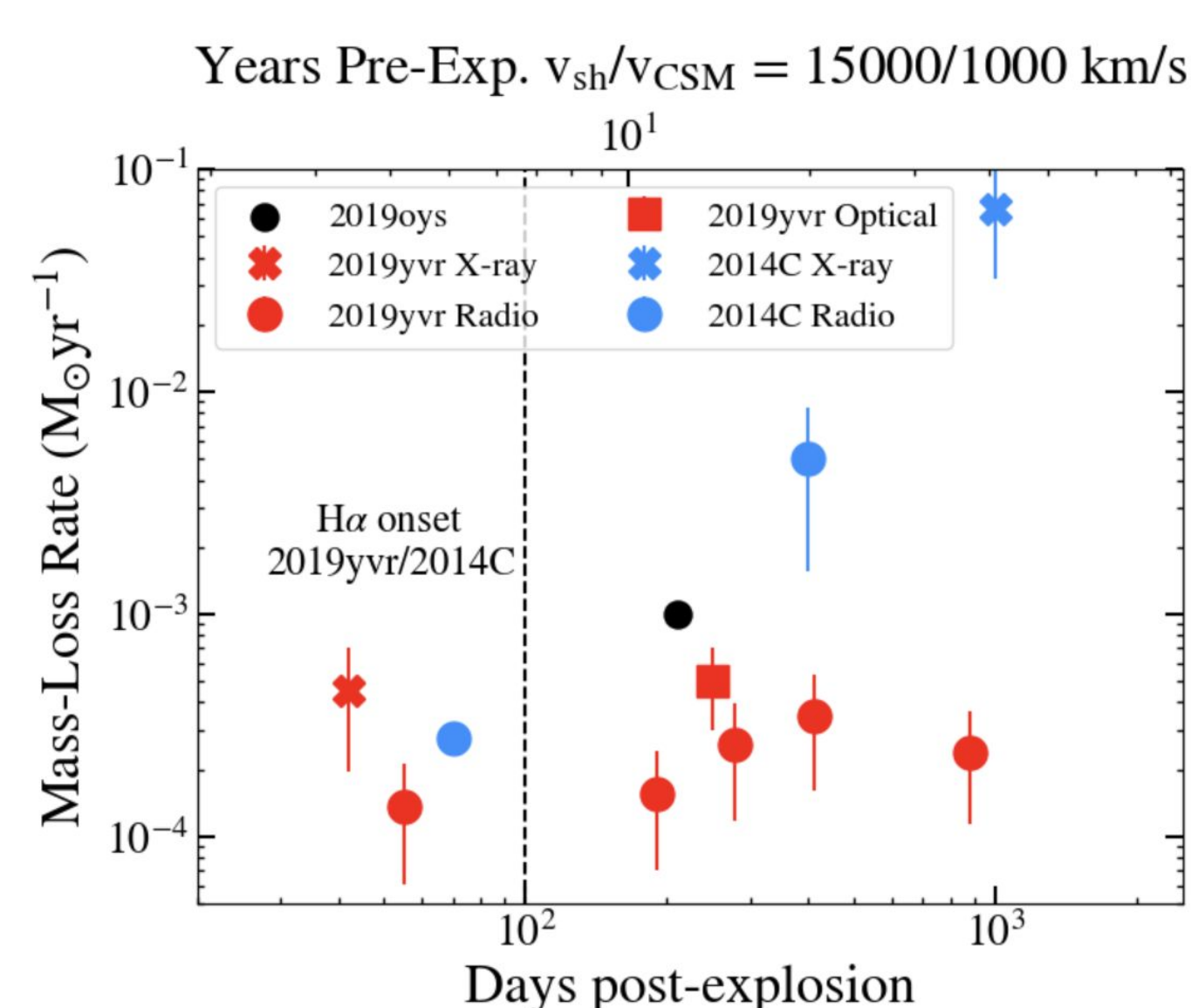
Kumar+RBW 2026

10-100 yrs pre-explosion

1-10 yrs pre-explosion



- ★ **Second-closest Calcium-Strong Transient (CaST)**
- ★ **X-ray Detection–modeling implies CSM mass~0.1 M_⊙**
- ★ **X-ray emission in all CaSTs? 3 closest objects all with X-ray detection**
- ★ **Strong Helium NIR lines do not match thermonuclear models**
- ★ **Dense confined CSM confirmed with late-time radio data**
- ★ **CSM density picture does not match typical SESNe--neither core-collapse nor thermonuclear models can be ruled out**



Takeaways

- ★ **Early-late radio and X-ray observations are vital to constrain circumstellar environment by precisely determining the CSM density**
- ★ **Need for early spectral classification and multiwavelength triggering for SNe Ibn**
- ★ **Deeper X-ray observations of CaSTs (with longer exposure times/with Chandra or XMM) are needed to truly diagnose the environment and determine if they are core-collapse or thermonuclear explosions**
- ★ **Are SNe Ibn and CaSTs related?** CSM details suggest possibility, but optical differences remain and more understanding of the extended CSM environment is needed