Working Together to Understand Novae

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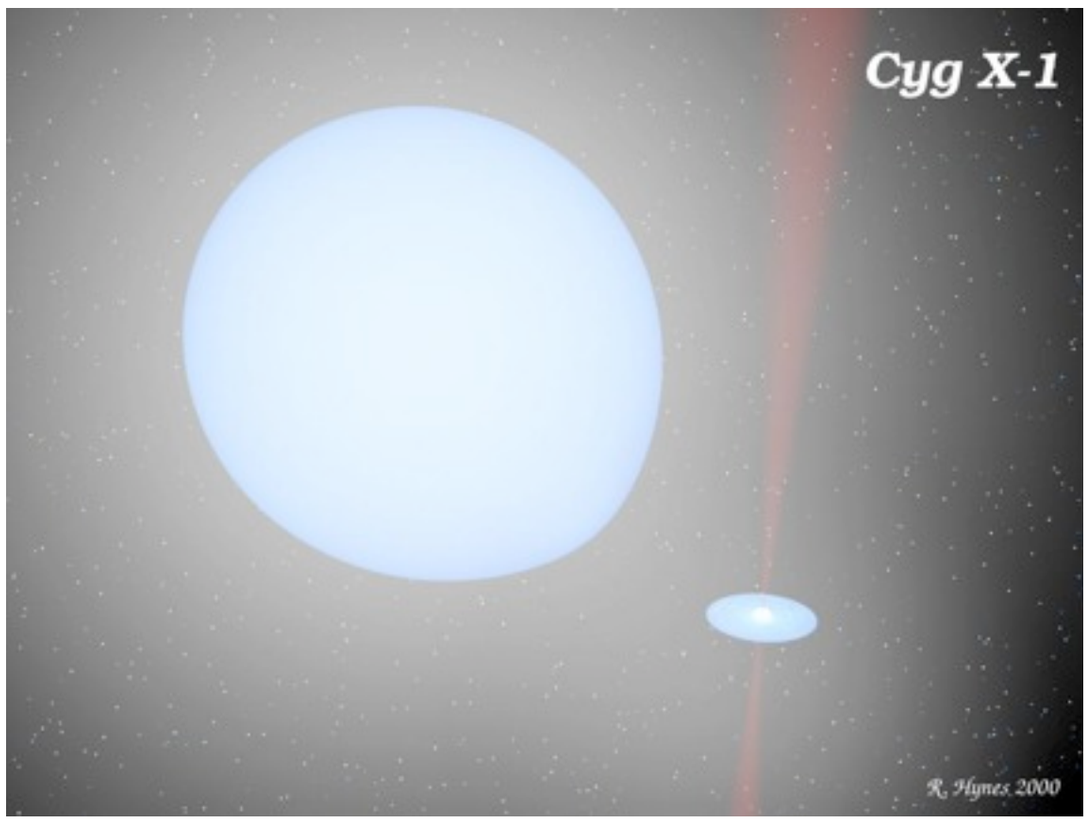
Binary stars: the building blocks of our Universe

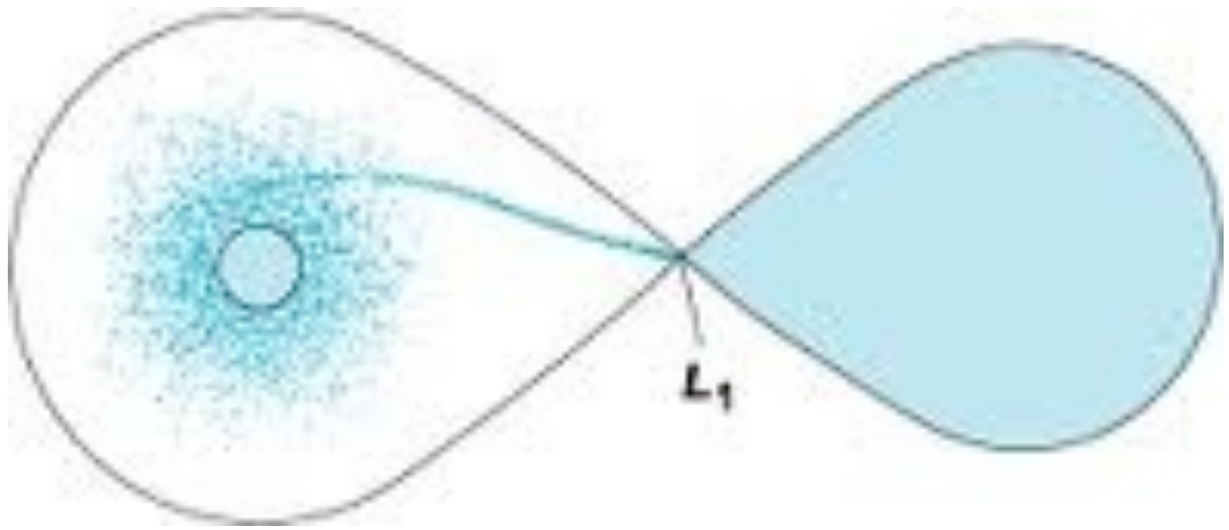
The more massive of the pair evolves first.

Mass transfer

Wide:

Narrow:





Bondi-Hoyle wind capture

Roche-lobe overflow

Novae

In an ideal gas, $P \propto nT$.

P increases when T increases.

In a degenerate gas, P does not depend on T.

When burning begins at the base of a degenerate white-dwarf envelope, a thermonuclear runaway ensues.

➡Novae are the most common stellar explosions.

~30 /year / galaxy

➡Almost all discovered by amateurs.

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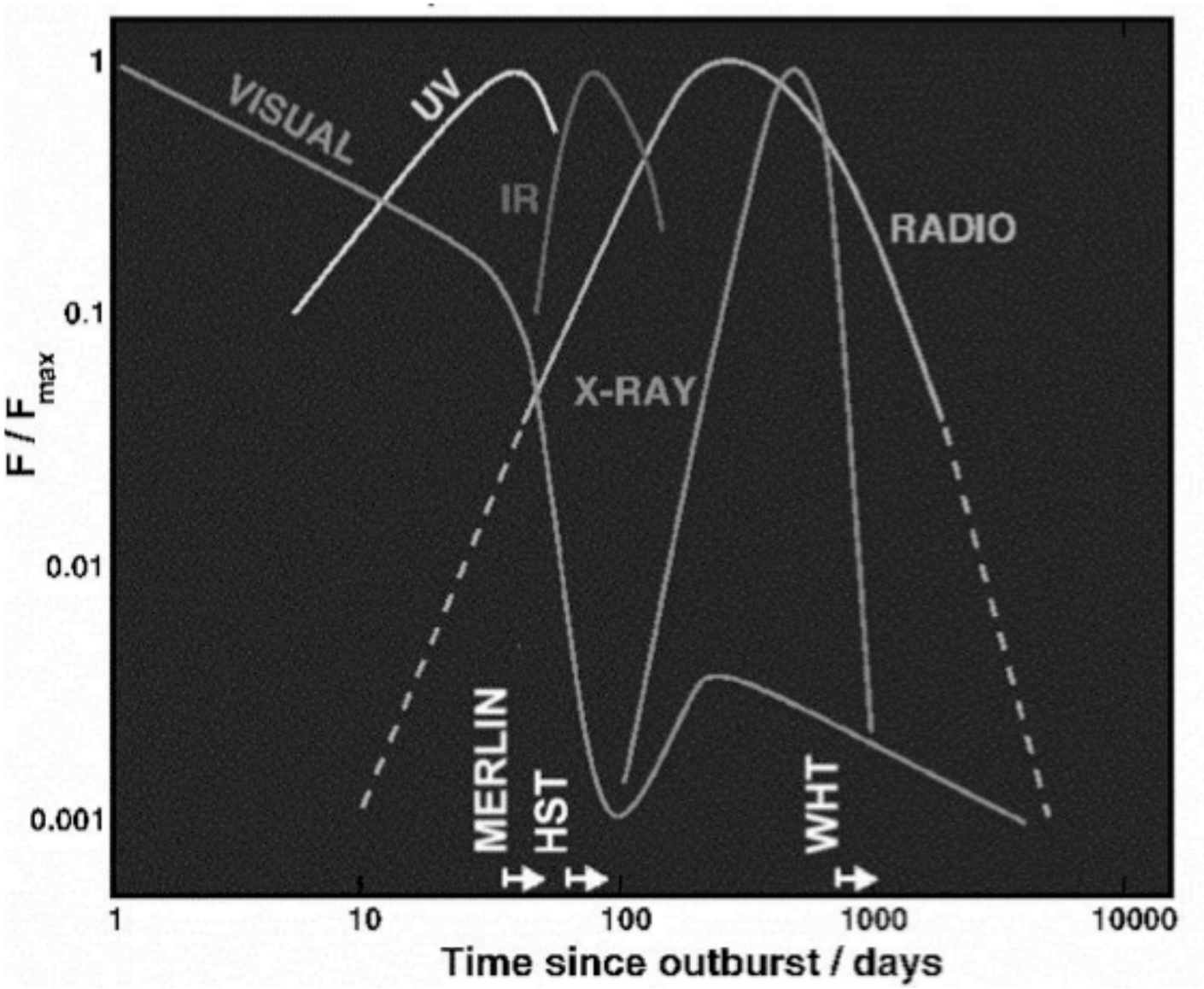
Novae at various wavelengths



Expanding and contracting ball of hot gas.

Problem: Observers claim these explosions eject 10 times more material than theorists predict.

➡ Which group is right has important implications.

➡ Ejecta mass tied to fundamental properties of this type of stellar explosion.

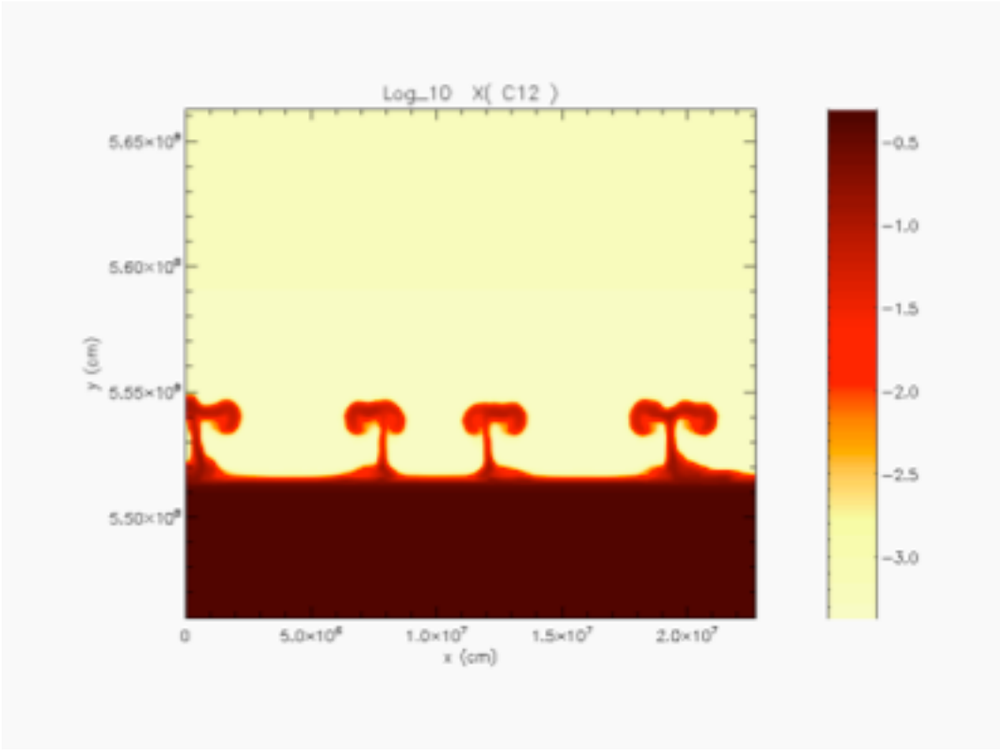
Physics of the TNR:

Mixing

Nuclear reactions

Binary stellar evolution

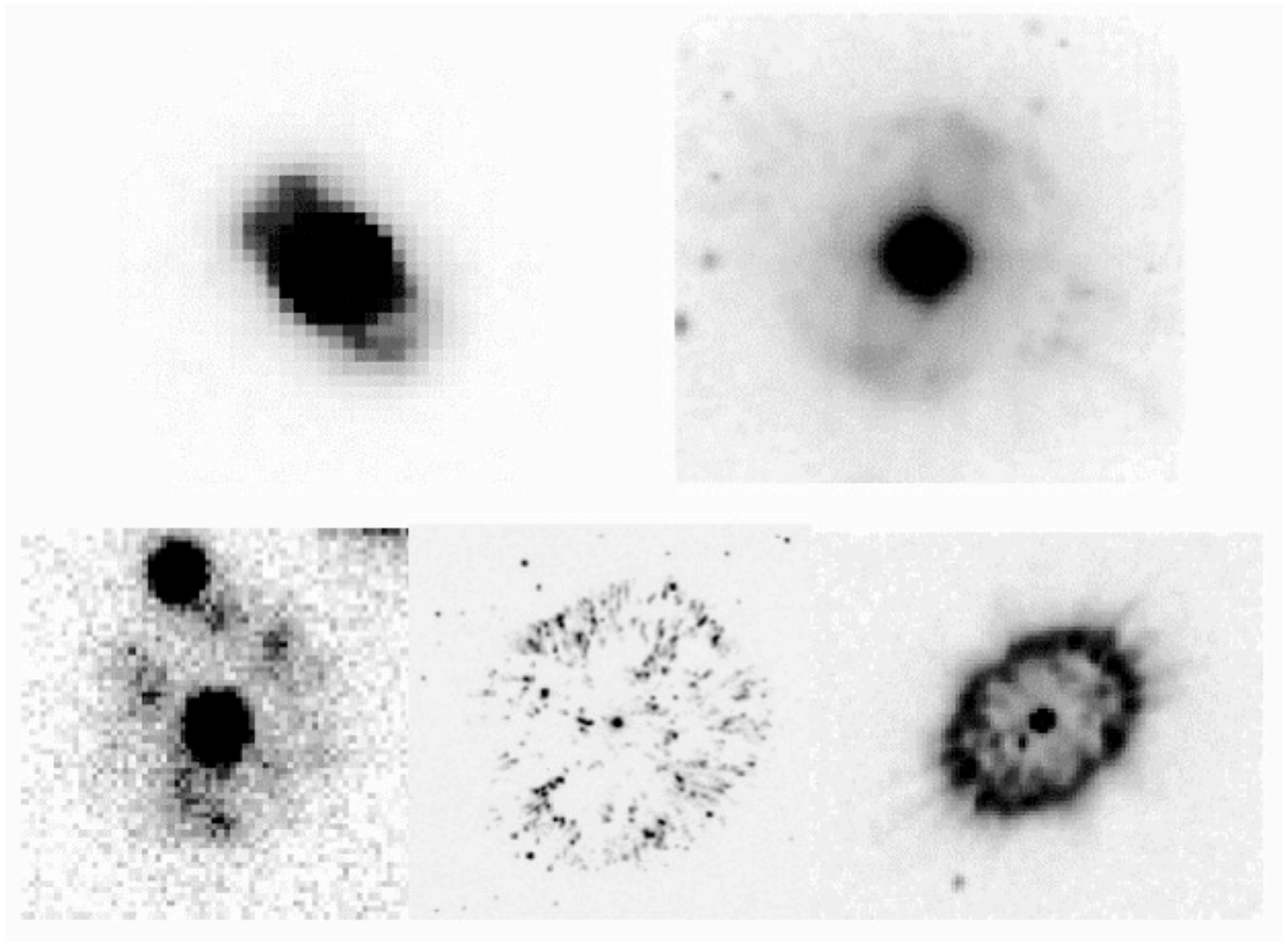
Fraction that become SNIa



Casanova+ 2011

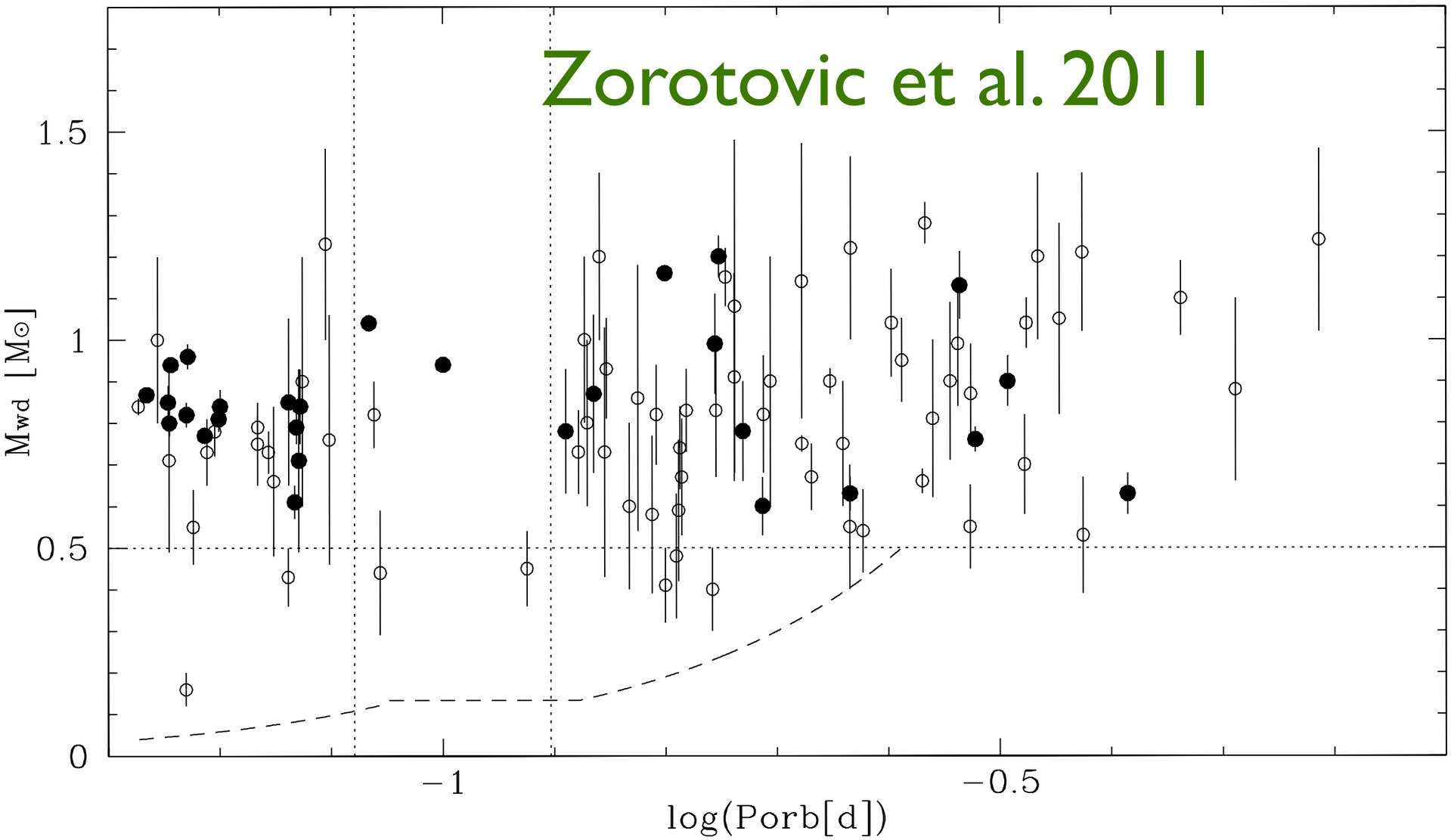
Assumptions: $n \propto 1/r^2$; $v \propto r$; spherical; T_e = const

Images of nova shells



Optical (emission line) images reveal clumps, rings, and asymmetries.

Masses of Accreting White Dwarfs



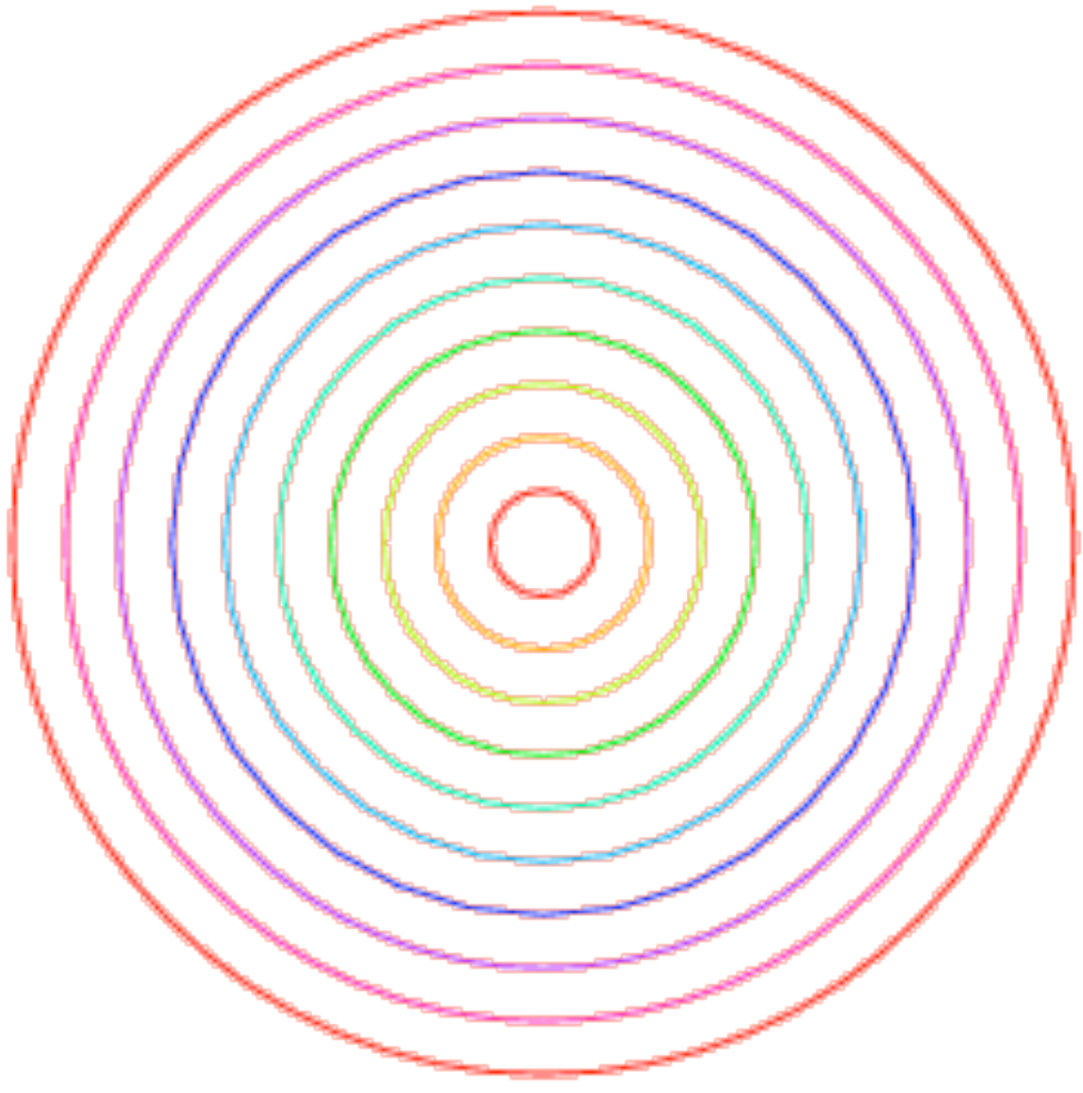
➡ Masses of accreting white dwarfs in narrow binaries are surprisingly high.

Radio observations to the rescue!

But radio observers cannot do it alone...

Peeling the onion:

As the ejecta expand, they become optically thin at the highest frequencies first.



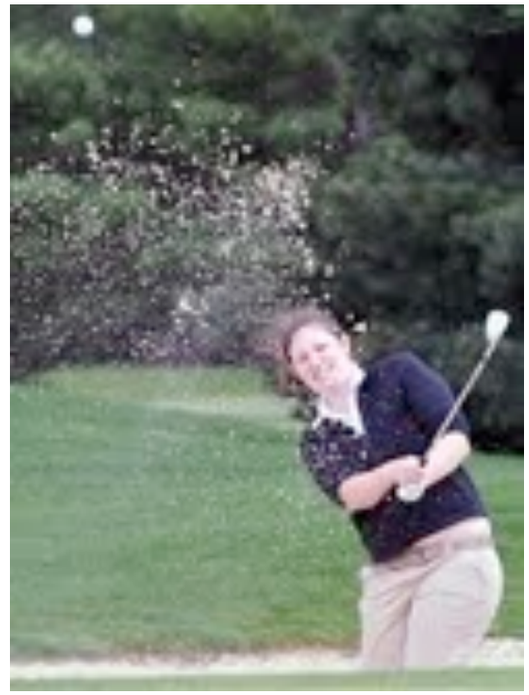
Radio images and multi-frequency light curves provide the temperature and density structure of the remnant.

Can test assumptions.

27 25-m diameter radio antennas, in New Mexico

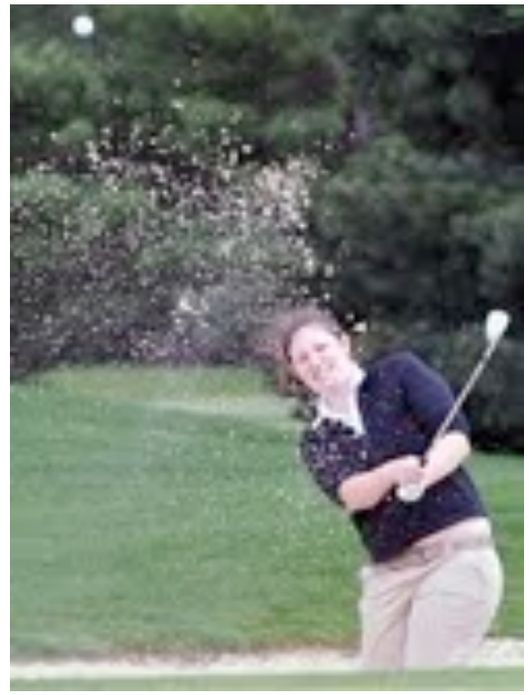
e-MERLIN

The E-Nova Project



The E-Nova Project

WE WANT YOU!



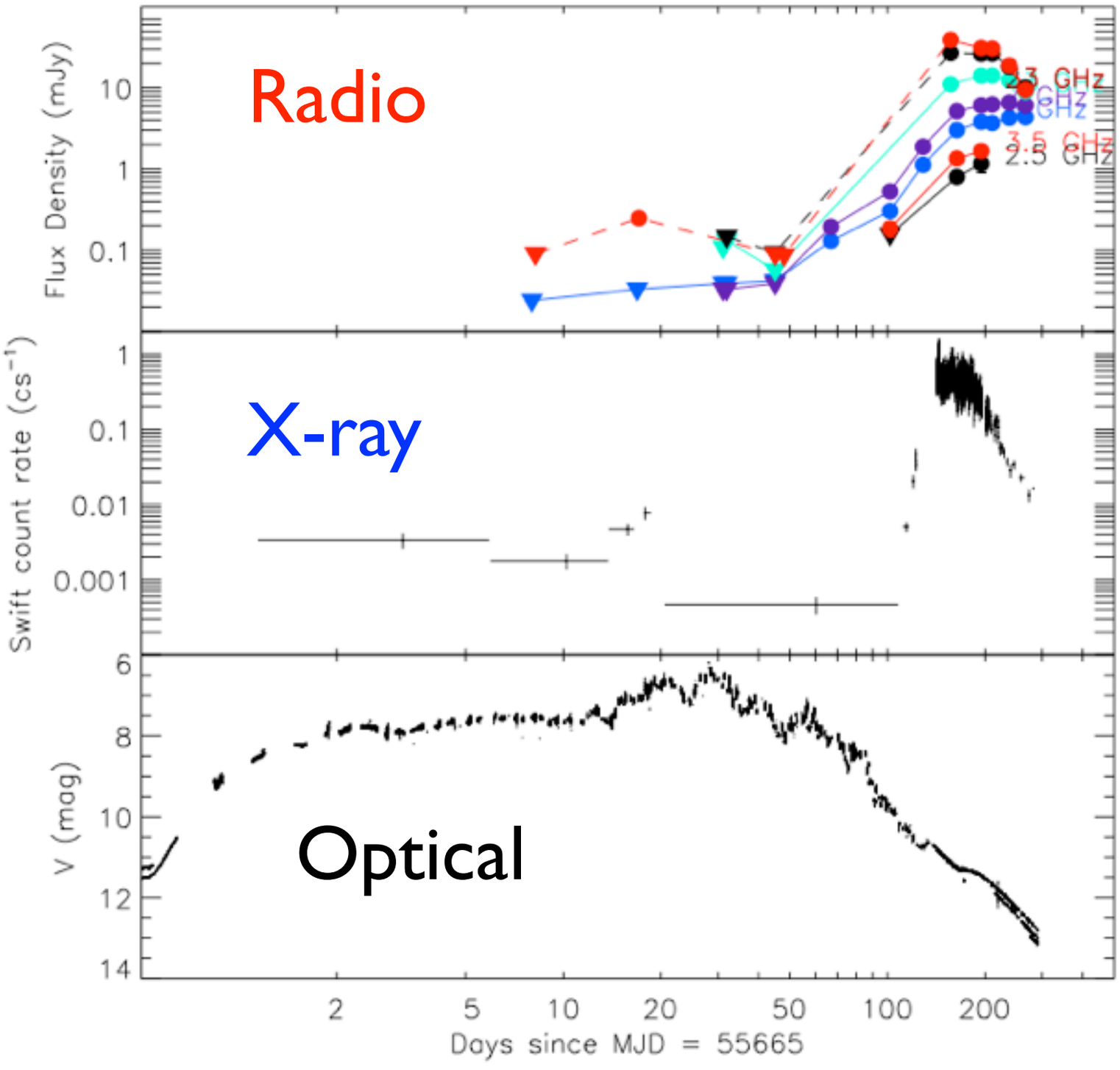
Role of Amateurs

Discovery: Most novae are discovered by amateurs, and it is estimated that half of all novae in the Galaxy are still missed.

Optical Light Curves: Professionals cannot get the kind of nightly (or weekly) coverage for months to years, that amateurs routinely do.

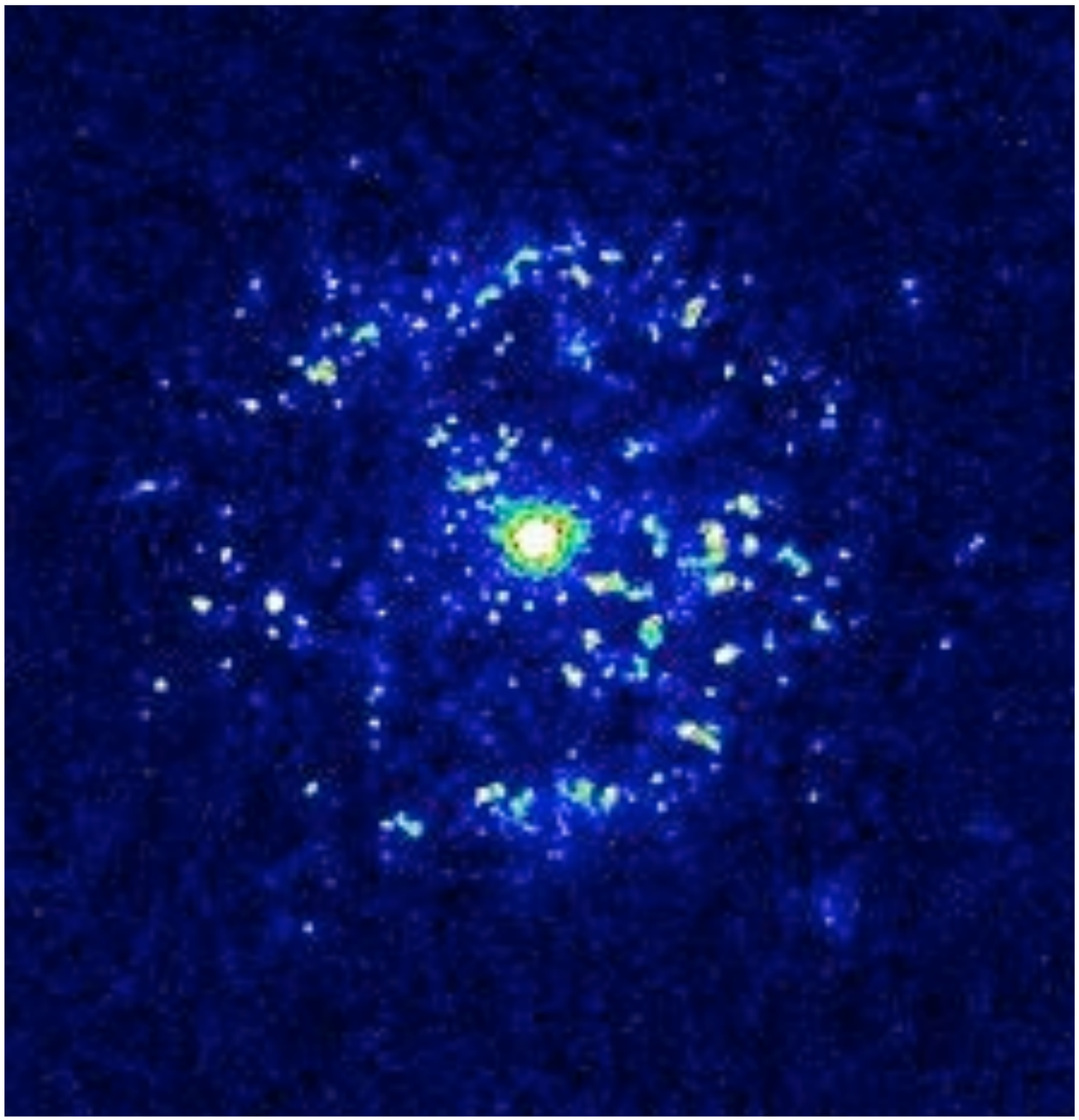
Optical colors and spectra fantastic for helping with physical interpretation.

T Pyx

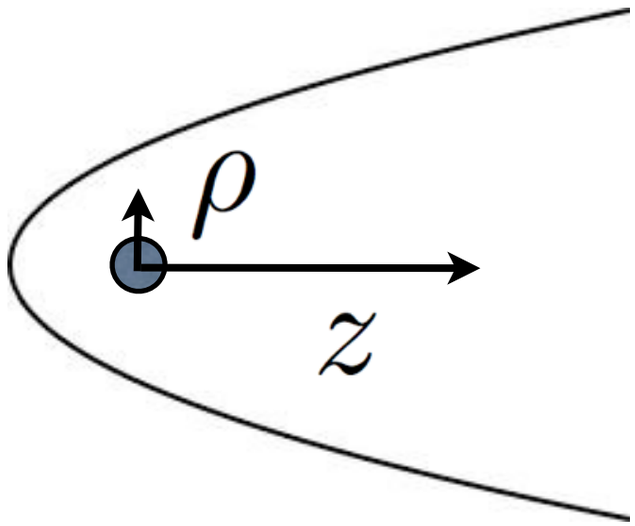


- Multi-stage ejection.
- Delayed ejection of most of the mass.
- $M_{ej} > 4x10^{-5}$ Msun
- X-ray from collisions among ejecta

Light-Echo in T Pyx



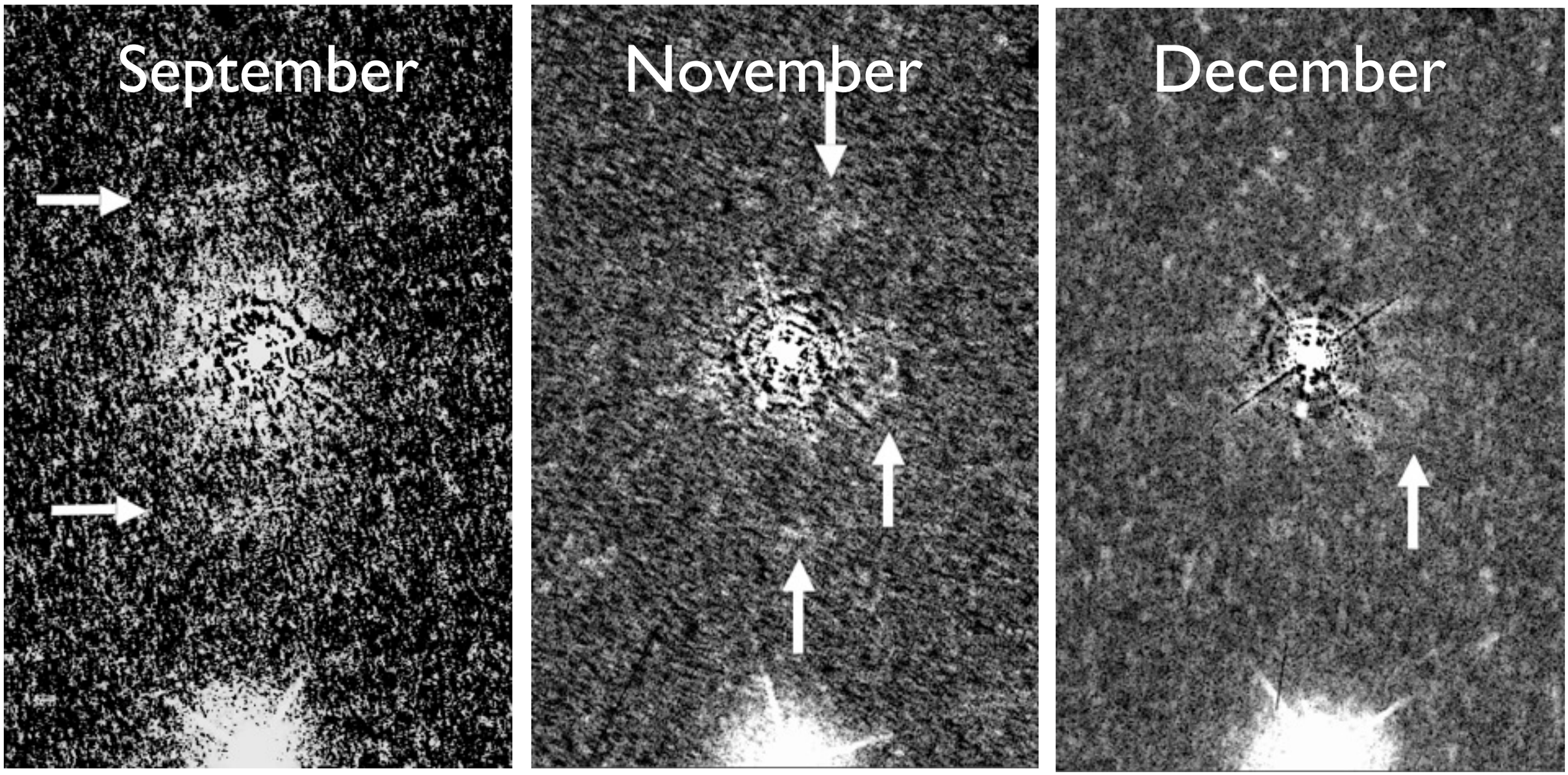
Distance from the Echo



$$z = \frac{\rho^2}{2ct} - \frac{ct}{2}$$

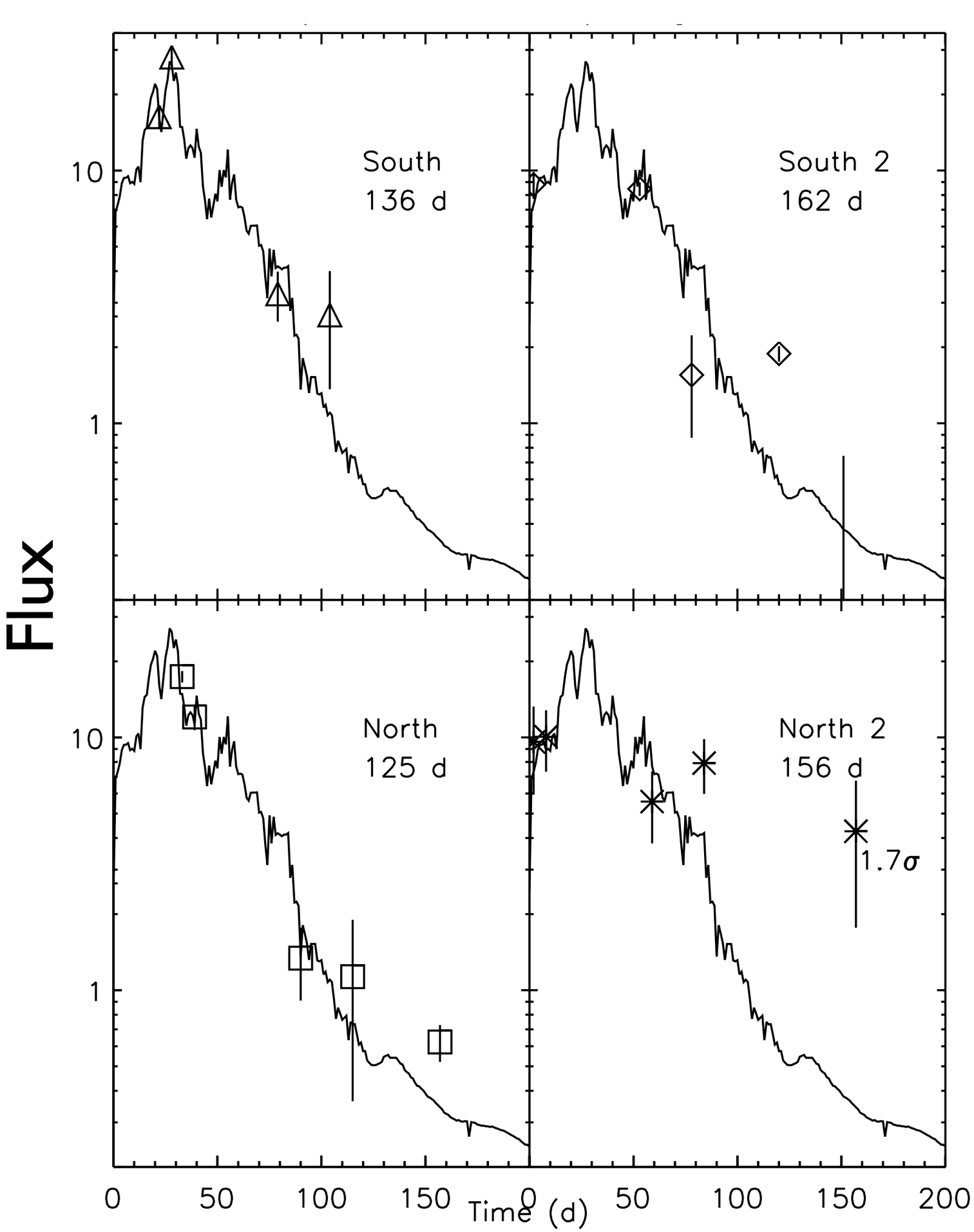
➡ Echo primarily from ring tilted around N-S axis.

Light-Echo Distance to T Pyx



East → West

Lag Times



4 echo patches give 4 distance estimates: 4.8, 4.7, 4.9, 4.8 kpc.

D = 4.8+-0.5 kpc

Summary

1. Novae are the most common stellar explosions.
2. Some of their most basic properties, such as how much mass they eject, and how they eject it, are still unknown.
3. The combination of radio and optical observations can solve these problems.
4. T Pyx is an example of how professionals and amateurs can work together to learn about novae.

➡Check out the nova forum!