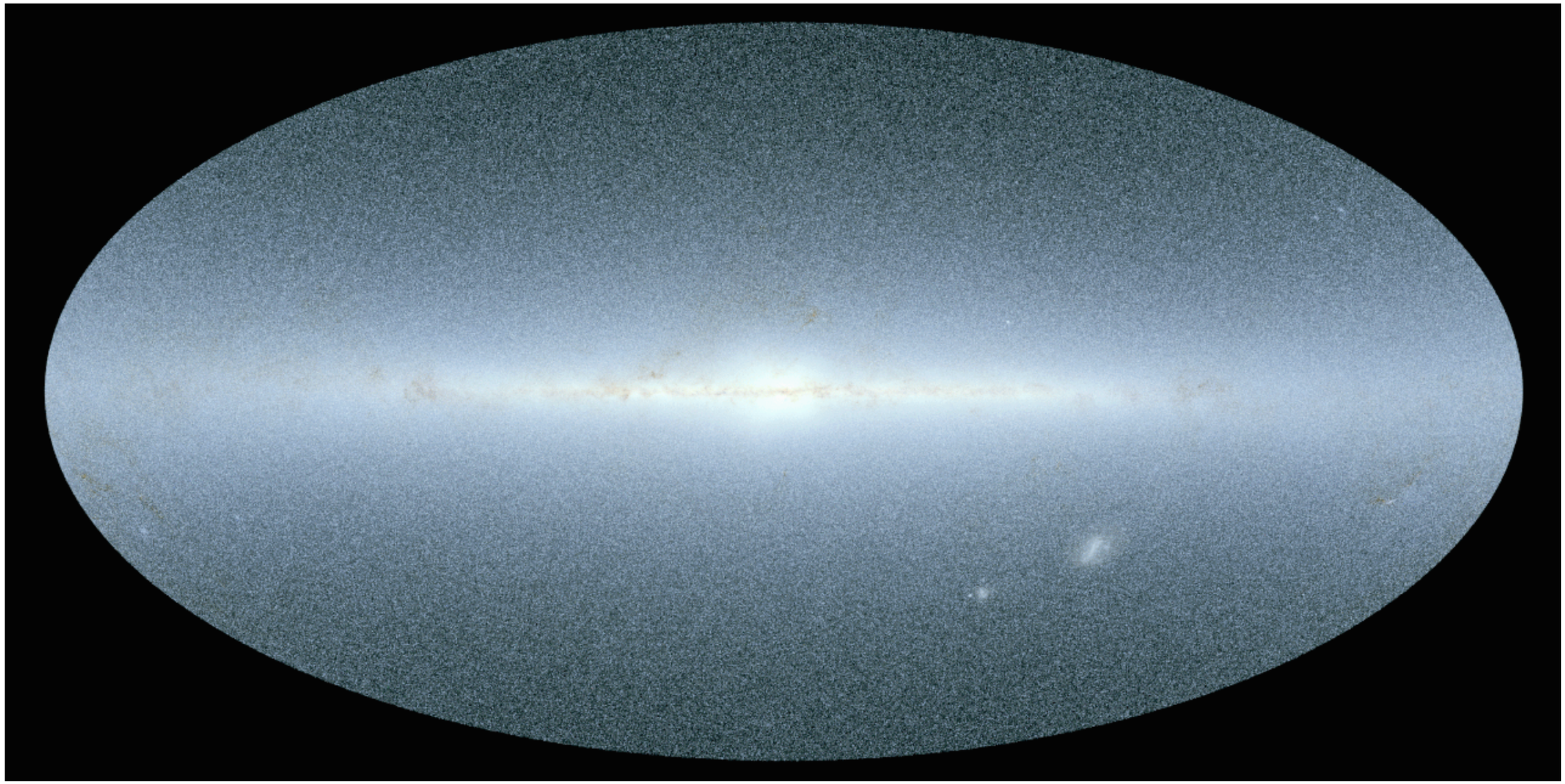
# Bursts, Pulses and Flickering: Exploring the Transient Sky



# So what do we expect to find?

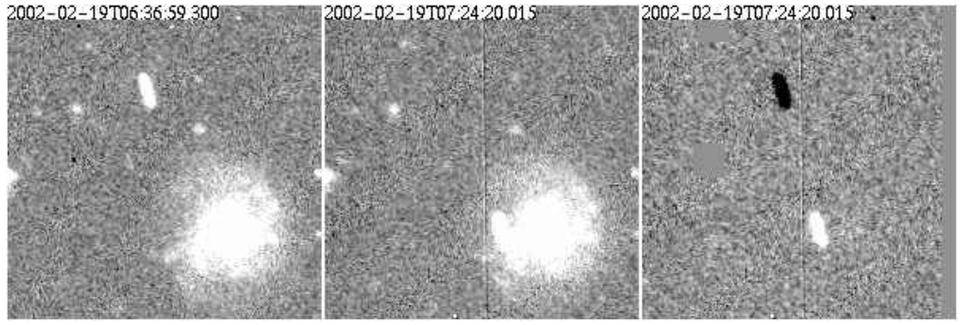
As we know,
There are **known knowns**.
There are things we know we know.
We also know
There are **known unknowns.**
That is to say
We know there are some things
We do not know.
But there are also **unknown unknowns**,
The ones we dont know
We dont know.

*US Sec Def. Donald Rumsfeld, DoD briefing, 12 Feb 2002*

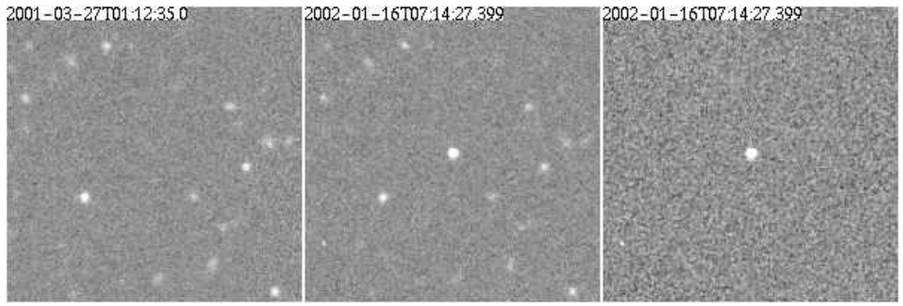
# So what do we expect to find?

## Supernova

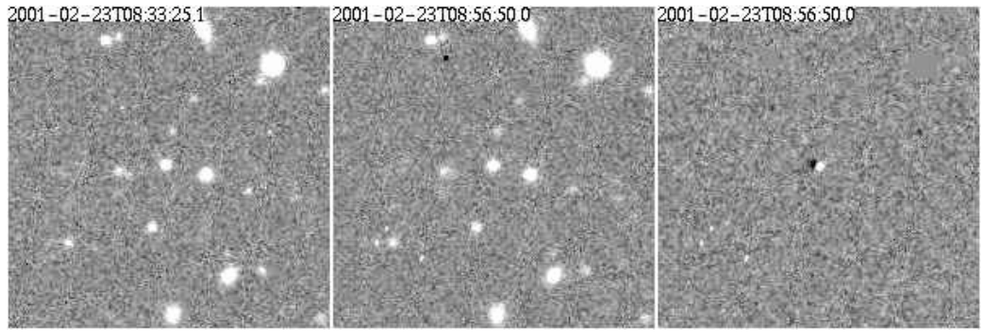

## Asteroid




## Transients

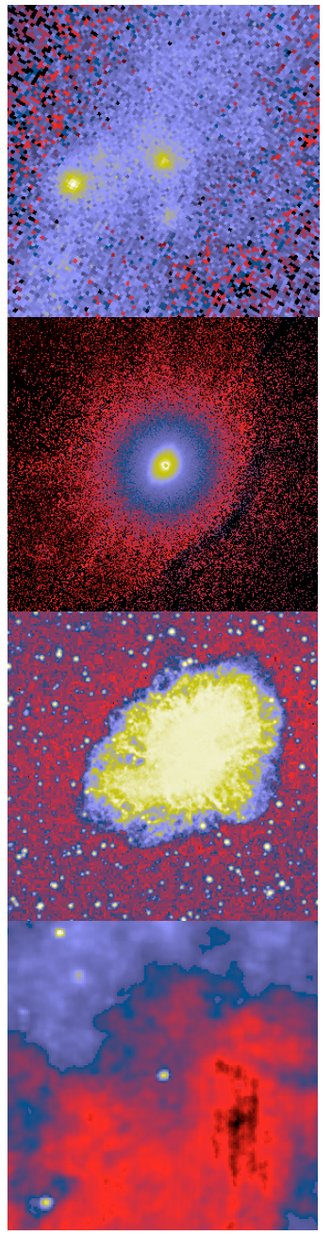



## TNO

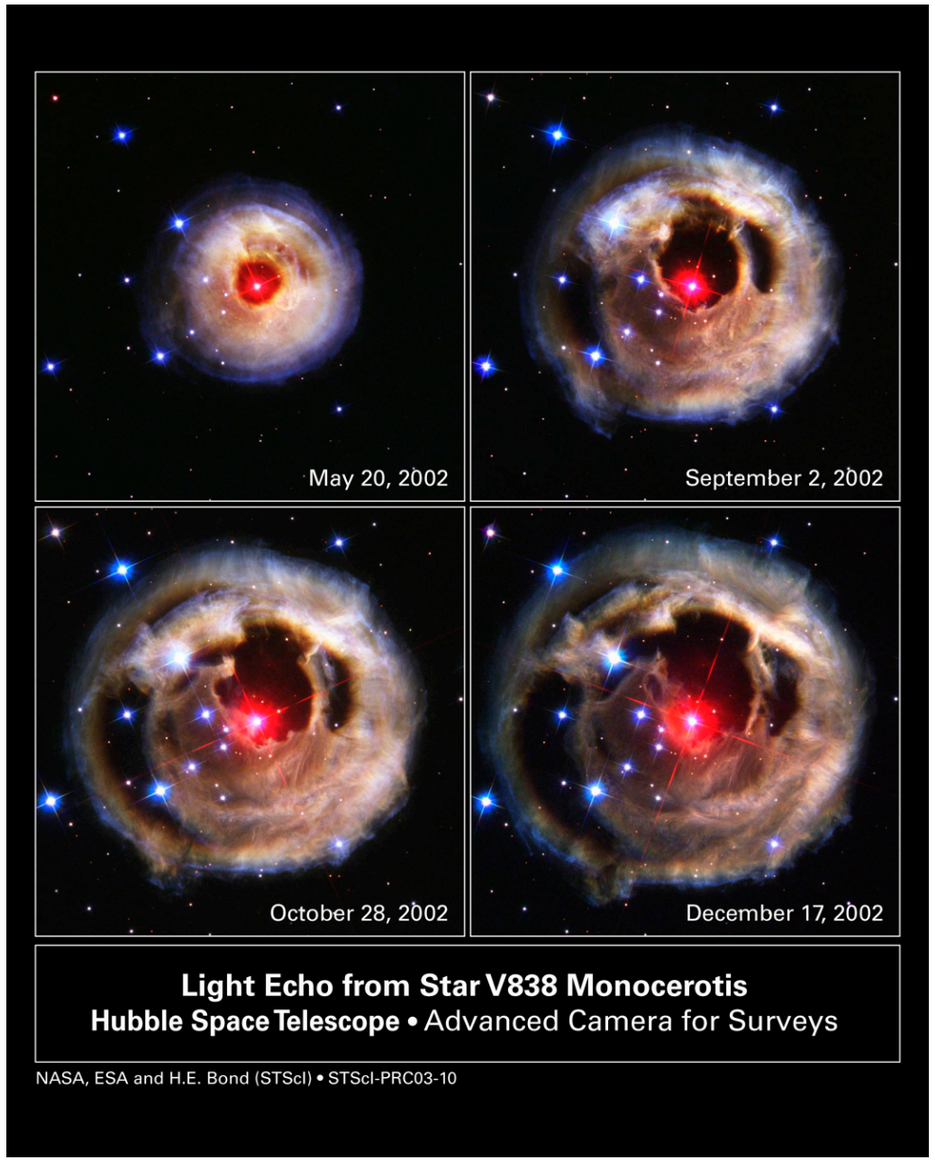


# Known knowns

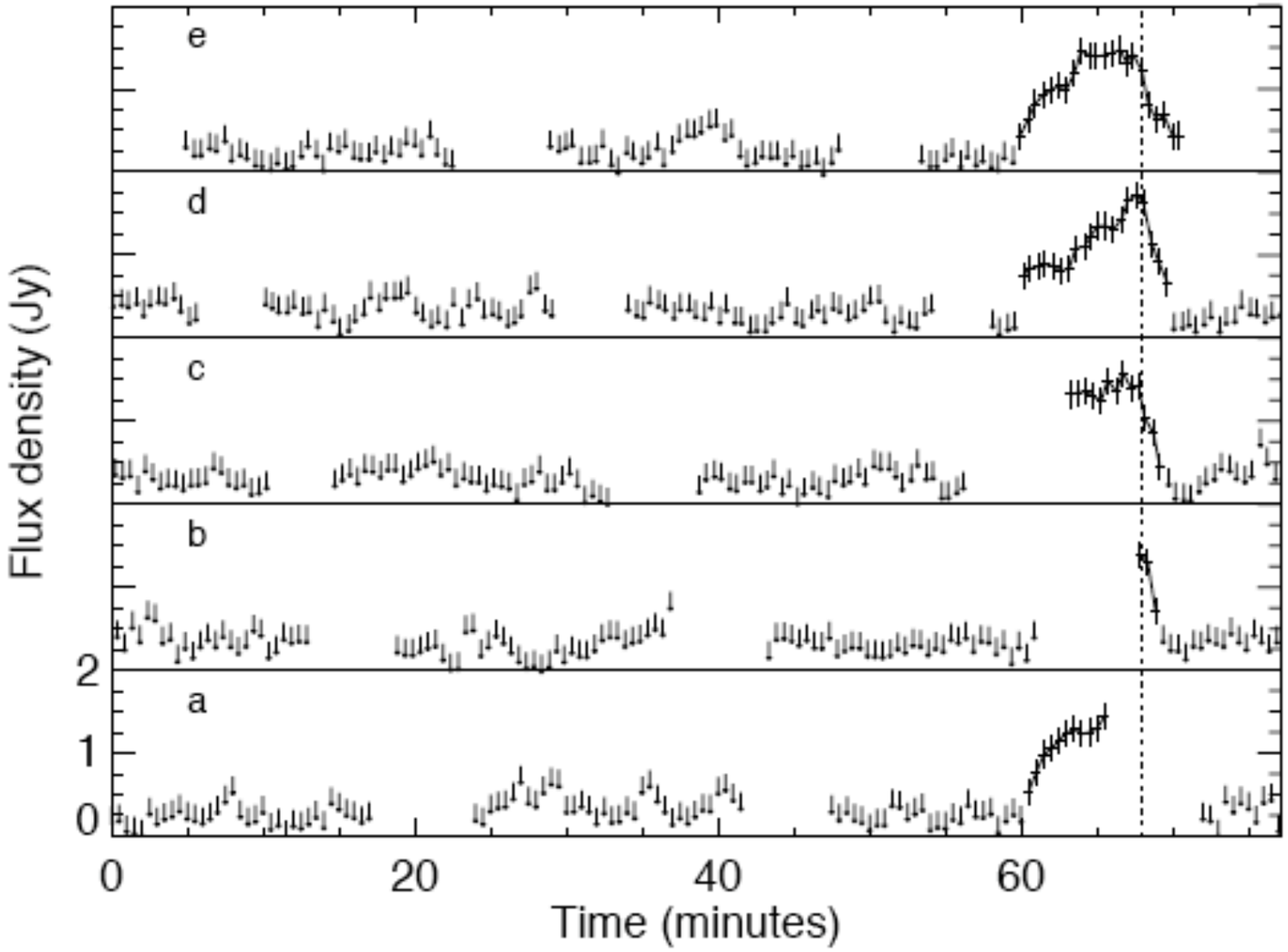
Planet Collisions
Brown Dwarf Flares
Flare Stars
Pulsars
X-ray Binaries
Supernovae
Gamma Ray Bursts
Variable AGN
Gravitational lensing
Dust echoes



# Known knowns



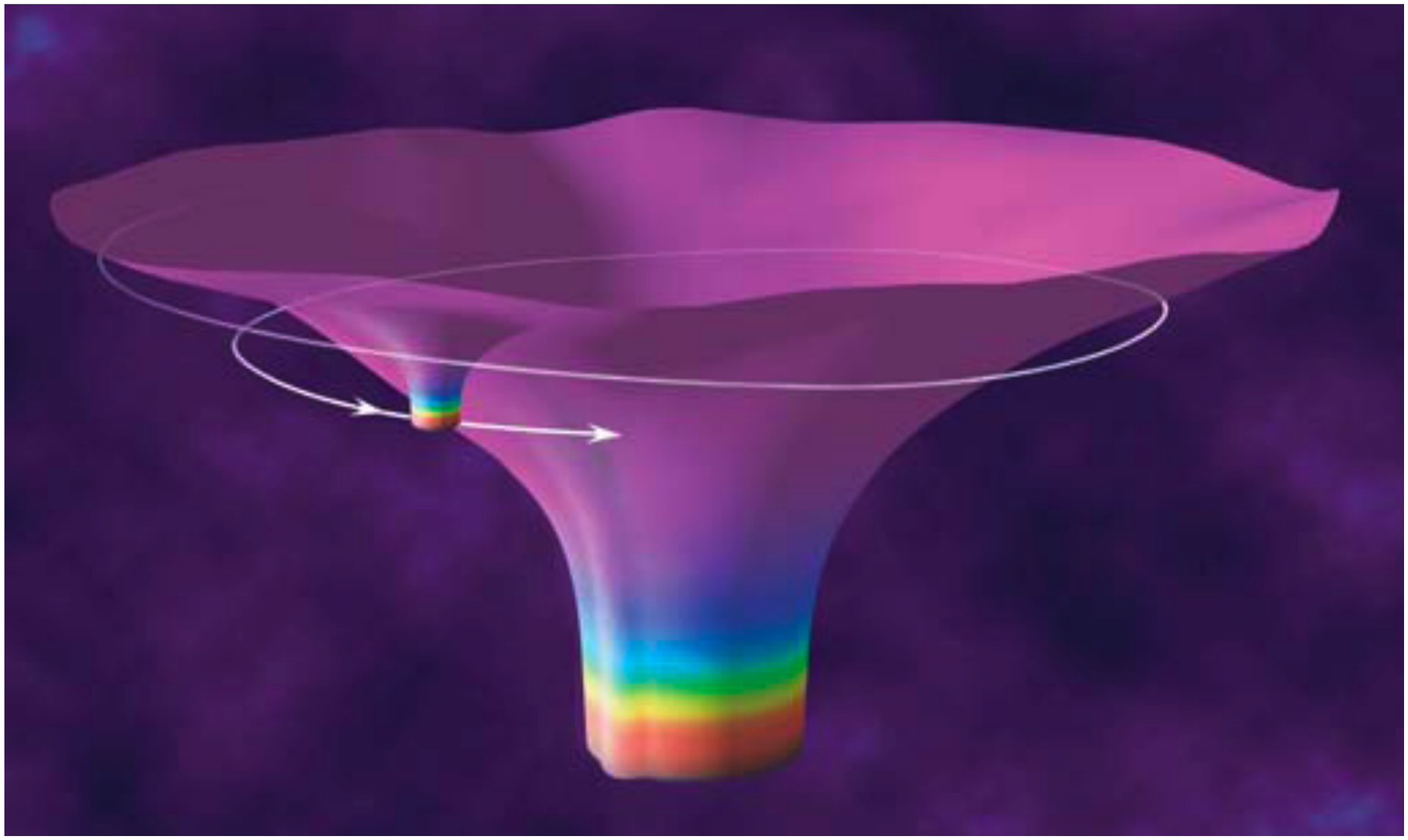
# Known unknowns




Discovered in 2002 — Hyman et al. 2005, Nature, 234, 50
1 Jy bursts, 10 mins long, every 77 minutes

# Unknown unknowns

Gravitational Waves Sources
Neutrino Sources
Cosmic Ray Sources



# Explosive transients

Stellar Flares (impressive but not explosive)
Novae
Supernovae
GRB Afterglows
Magnetar Flares

# Stellar flares

## LUMINOUS M GIANTS IN THE BULGE OF M31

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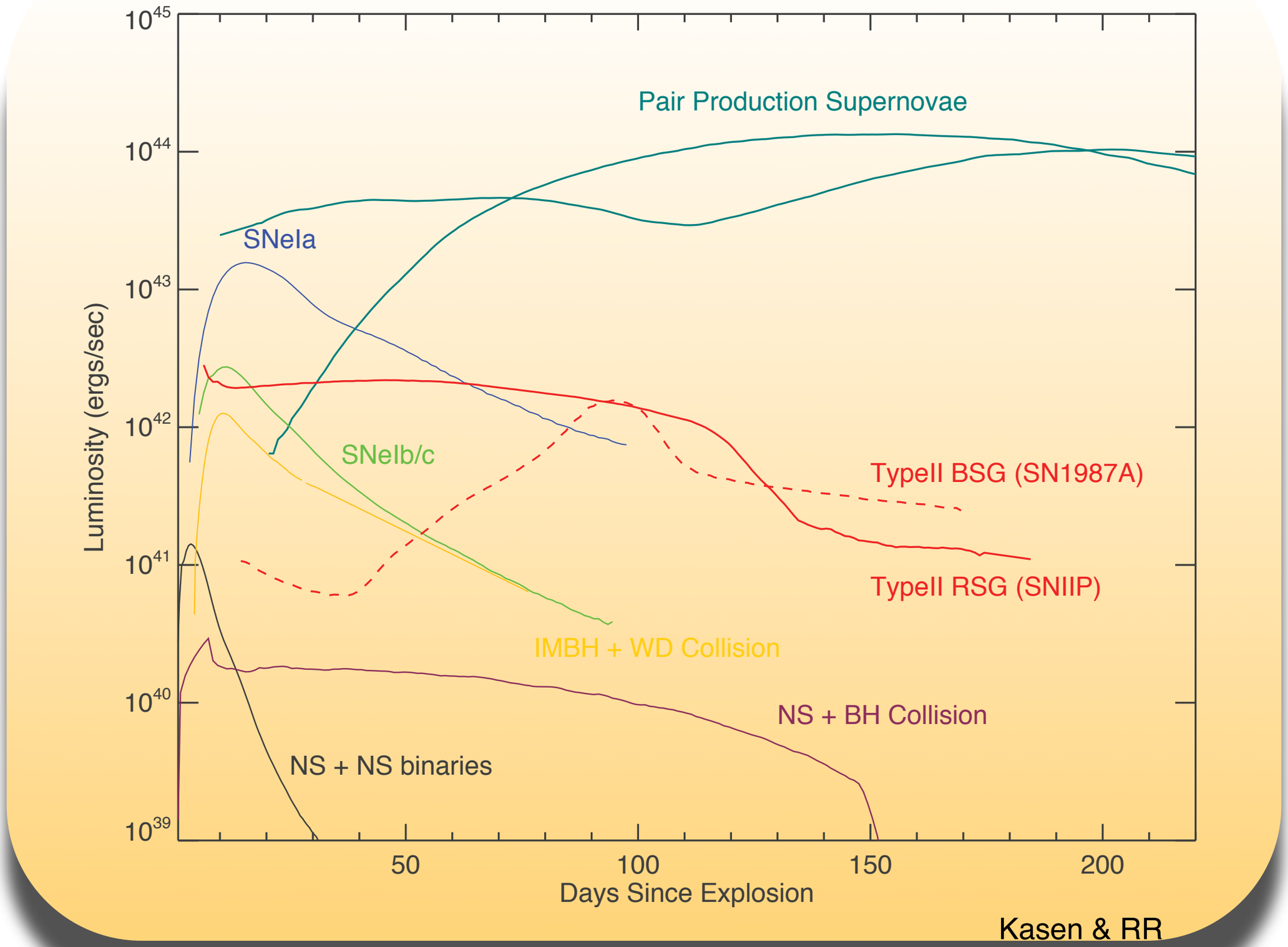
*Received 1988 October 17; accepted 1989 March 14*

### ABSTRACT

We report on spectroscopy of luminous red stars in the central bulge of M31. A number of these are shown to be late-type M giants similar to those in the Baade's window field of the bulge of the Milky Way. Among the M31 stars, we serendipitously discovered an exceptionally luminous M0 Ie red supergiant which has brightened by more than 5 mag in the last 2 yr. At peak brightness, this star was the most luminous red supergiant in the local group, with $M_{bol} = -10$.

# Explosive transients



# Supernovae

**expected rates**

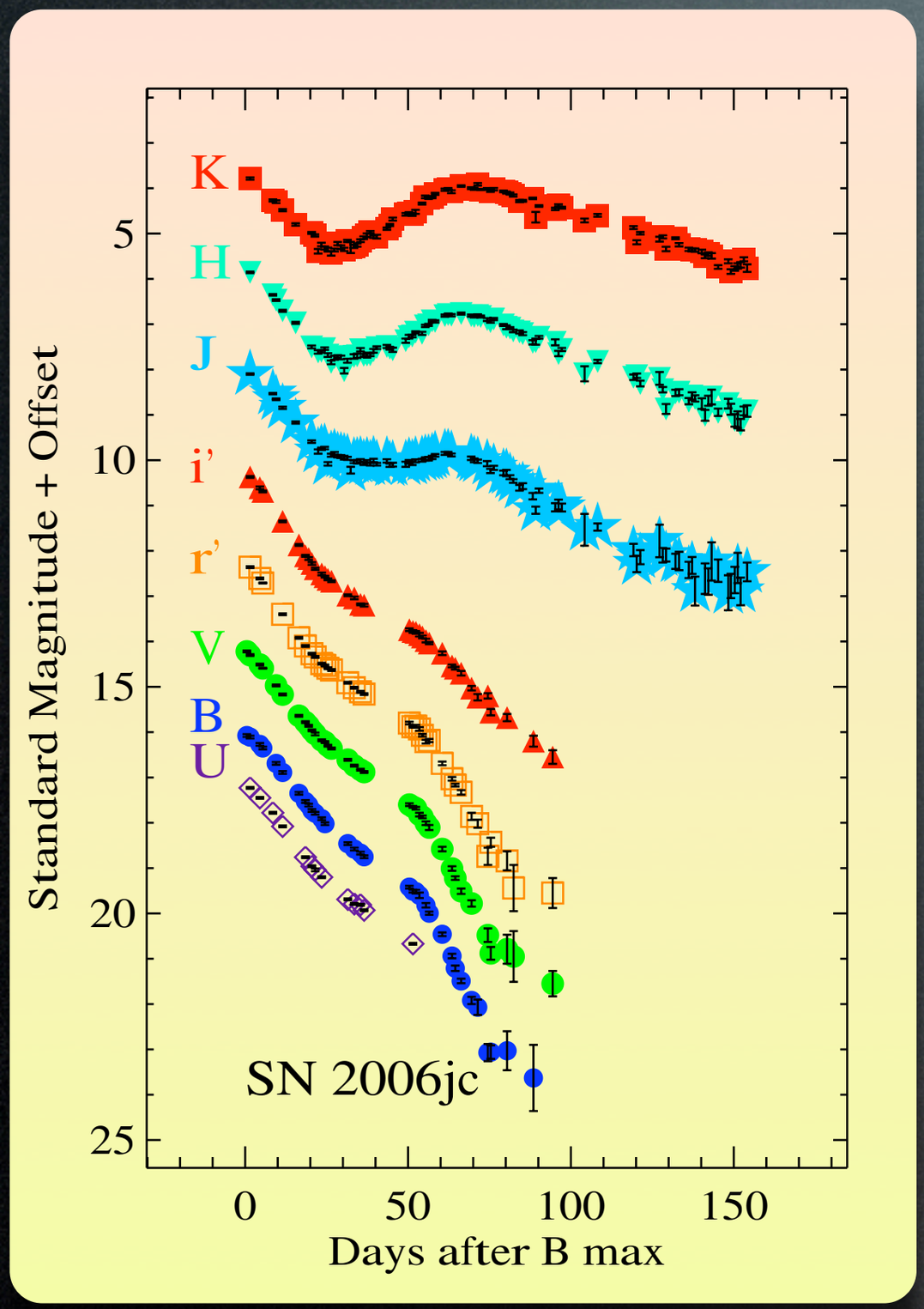
IIP: $z < 0.1$;  Ia: $z < 0.15$
1 yr, 45 epochs 1000 $deg^2$ → 900 Ia, ~300 IIP

**utility**

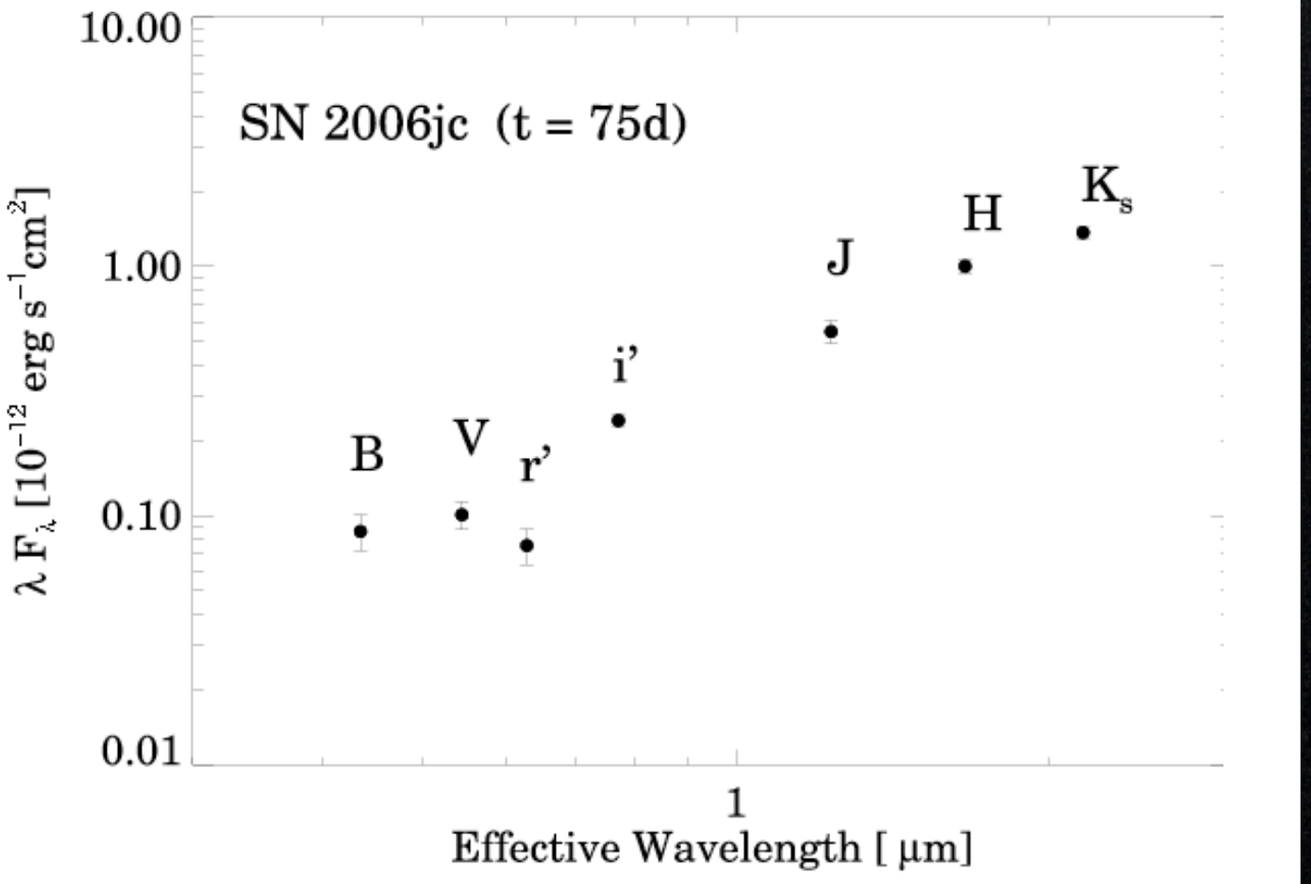
relative immunity to dust → low z anchor for cosmology
bolometric energy → progenitor details

**known unknowns in core-collapsed supernovae:**

peak-brightness distribution,
relative fractions of the sub-types,
statistical properties in general (e.g. rates as a function of galaxy SFR).




much of bolometric energy in IR at late times




Modjaz et al. 08

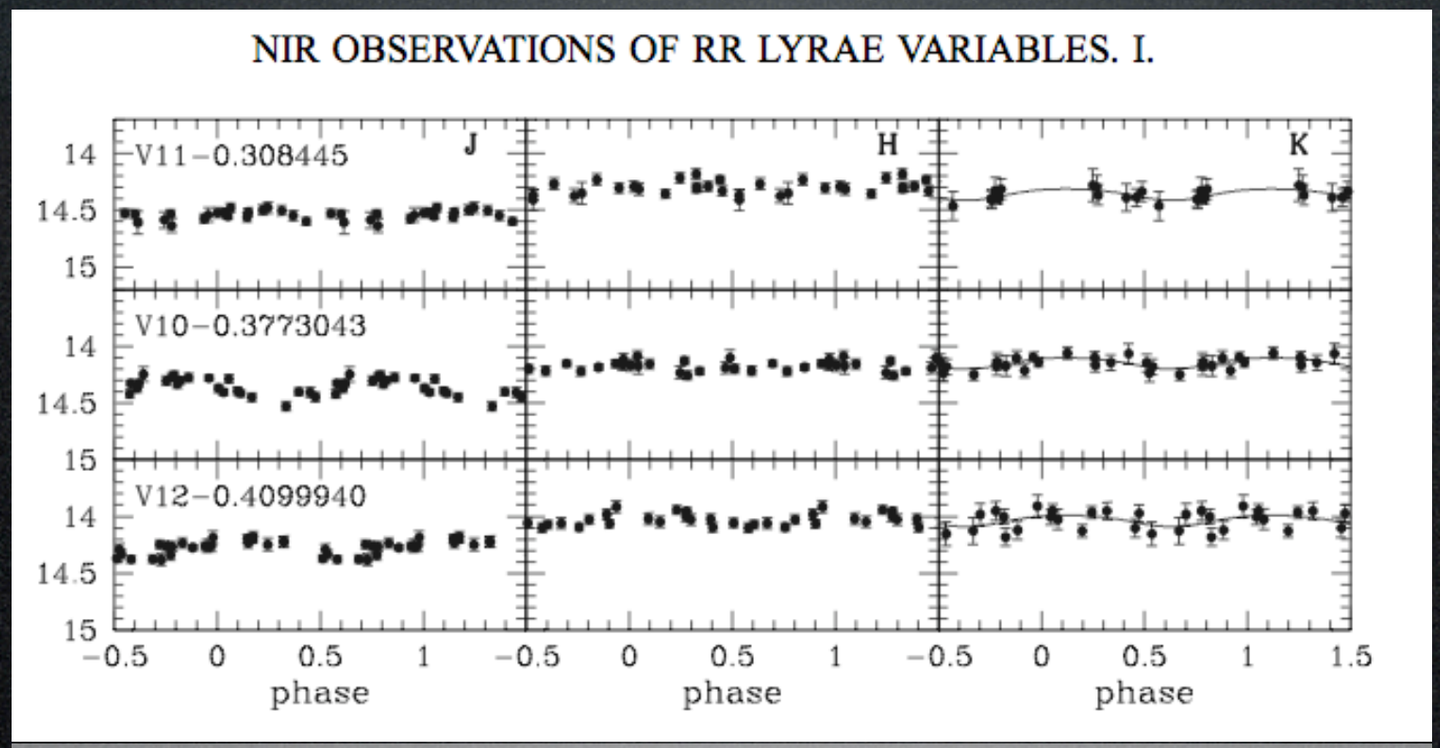
# Galactic Structure & Local Distance Ladder

***RR Lyrae & Cepheids***

☞ light curves less sensitive to metallicity so (theoretically) more standard

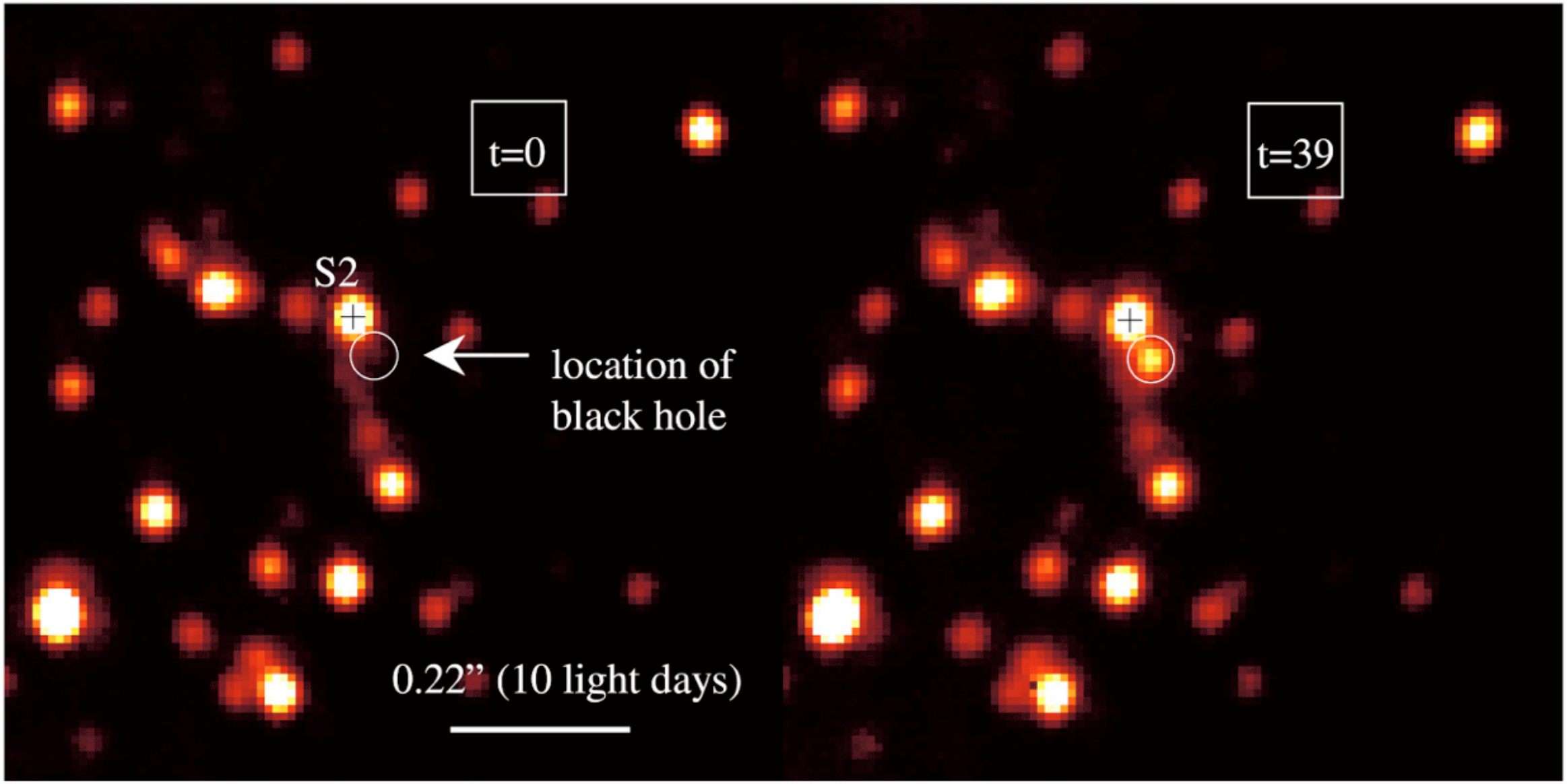
$$< M_J >= -1.902(\pm 0.045) LogP - 0.826(\pm 0.012)$$
$$< M_H >= -2.311(\pm 0.013) LogP - 1.136(\pm 0.003)$$
$$< M_K >= -2.343(\pm 0.012) LogP - 1.168(\pm 0.002)$$

*parallax with Gaia*




Del Principe et al. 05

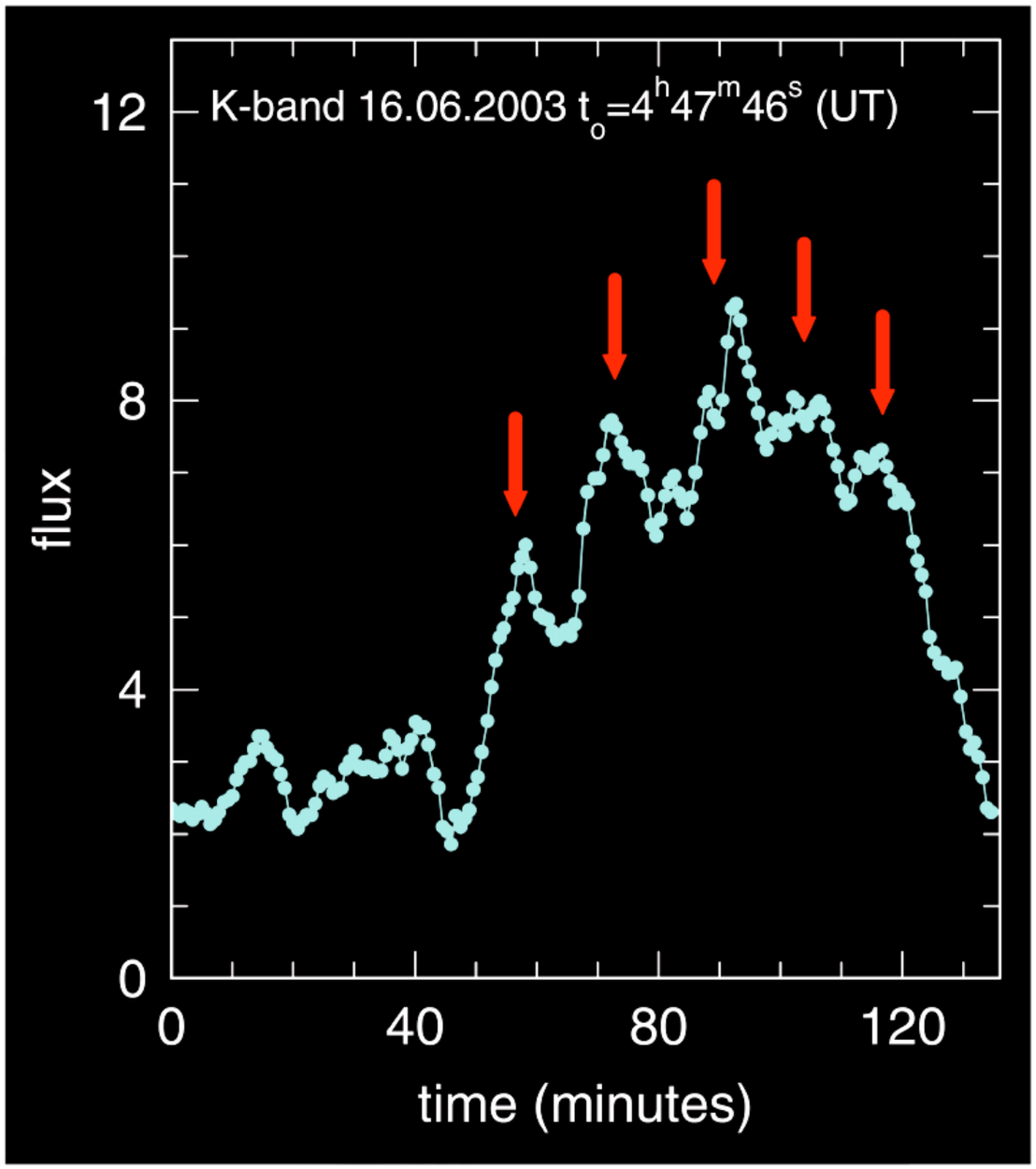
# SMBH: accretion flares




Near-IR Flare from Galactic Centre (VLT YEPUN + NACO)

ESO PR Photo 29a/03 (29 October 2003 )

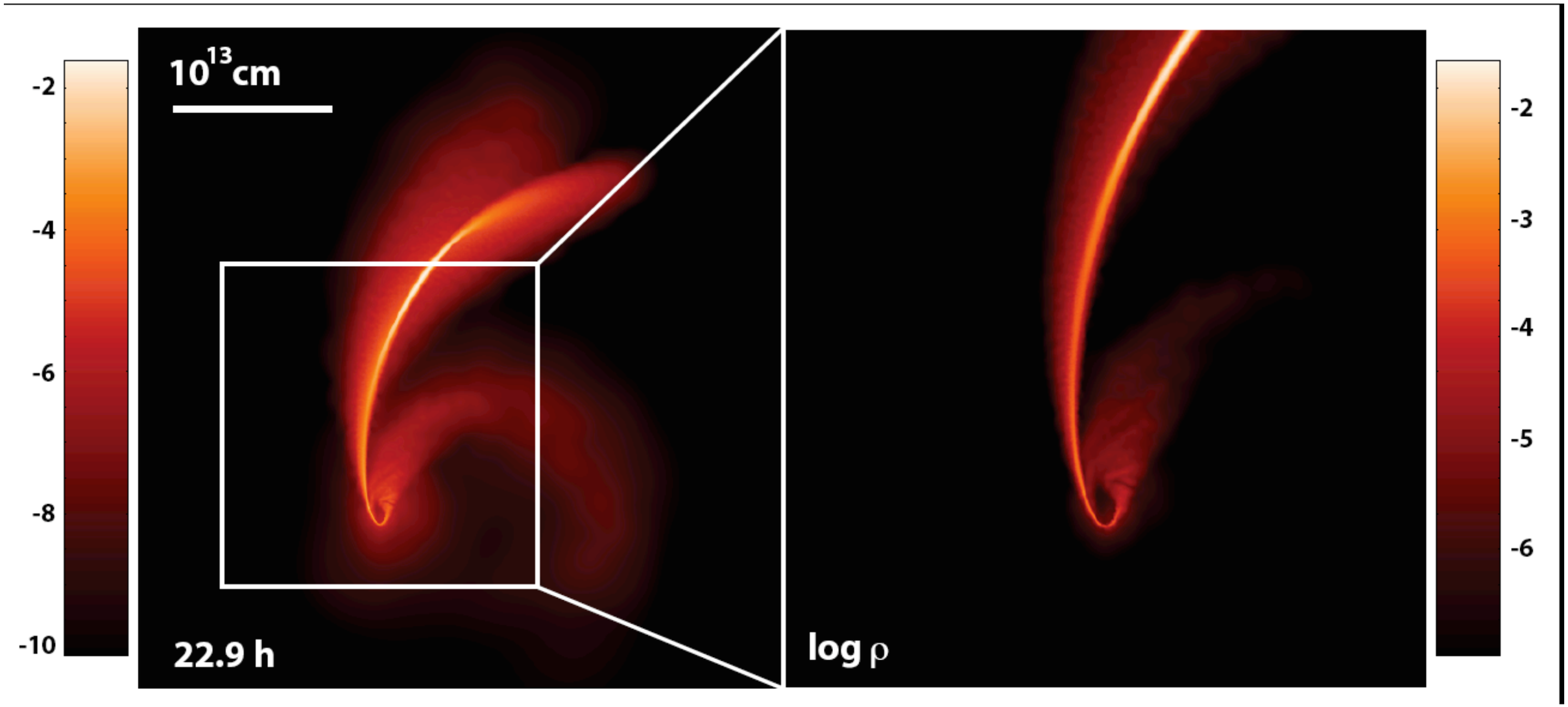
# SMBH: accretion flares



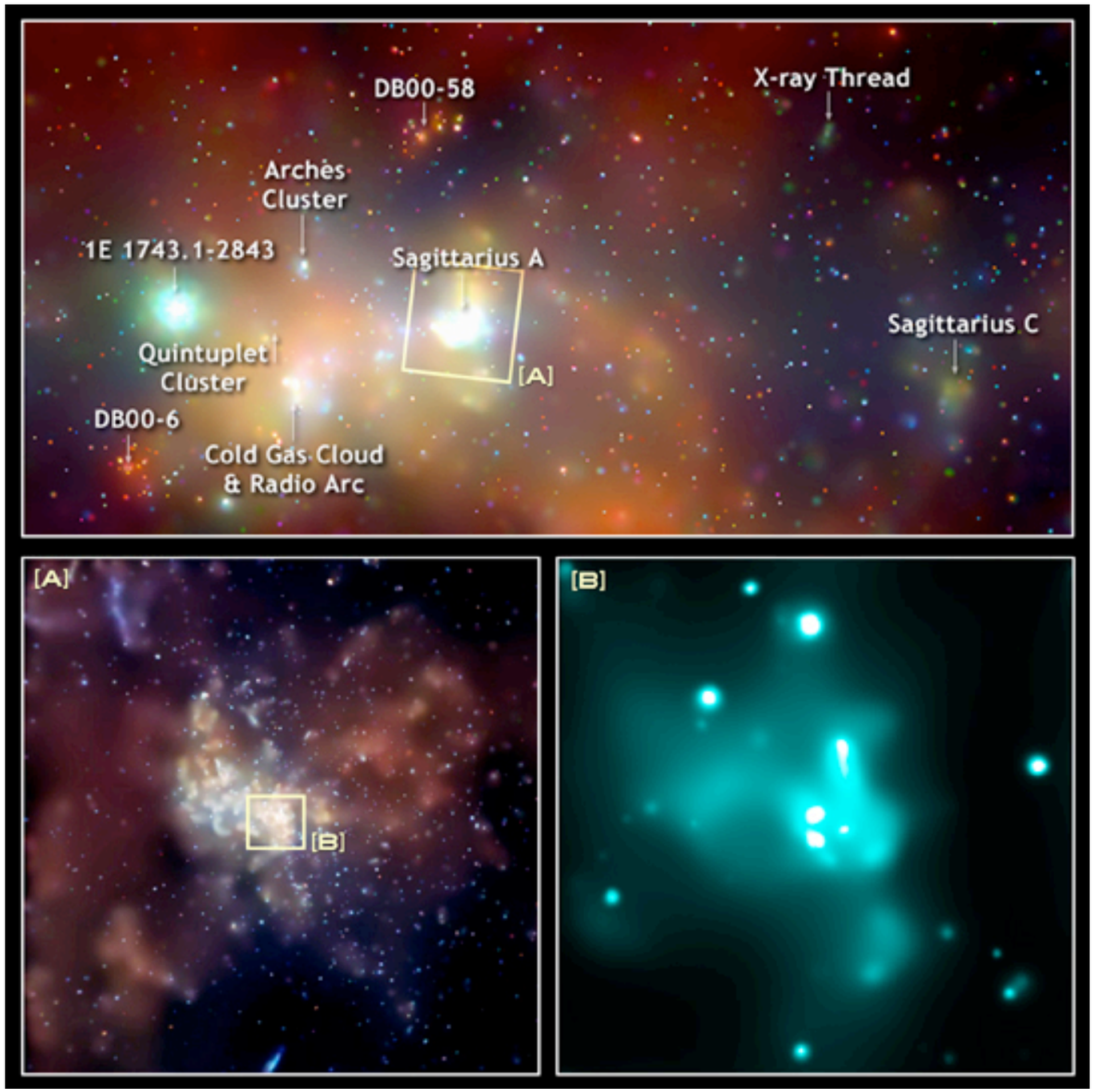

Near-IR Flare from Galactic Centre (Lightcurve)
(VLT YEPUN + NACO)

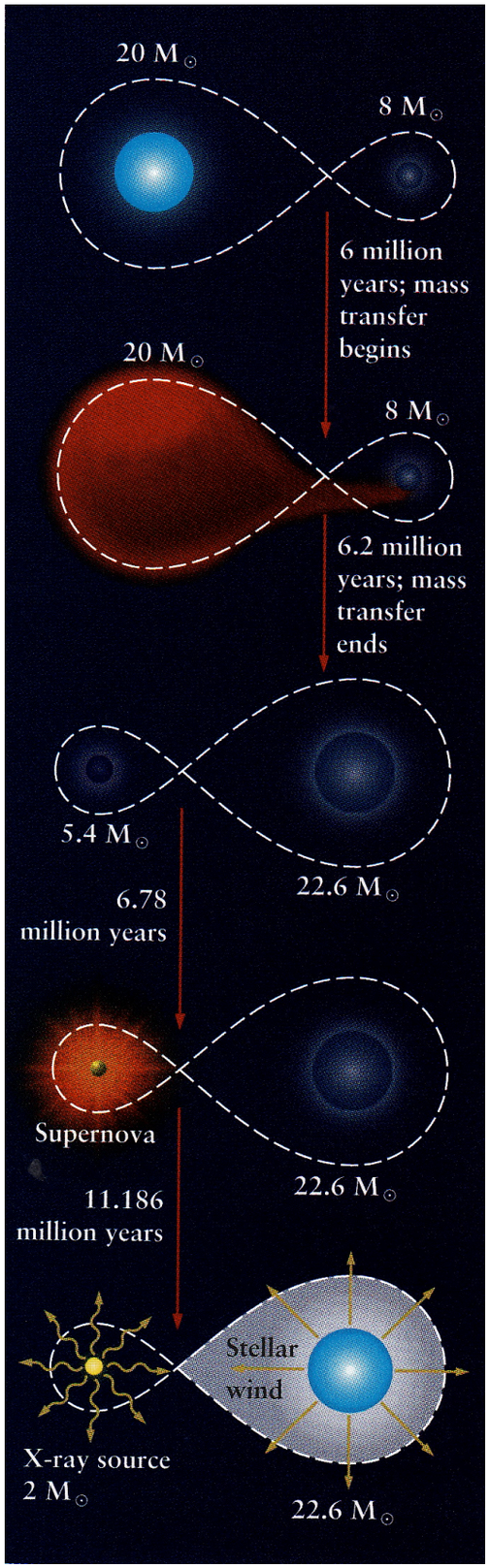
ESO PR Photo 29b/03 (29 October 2003 )

# SMBH: stellar ingestion

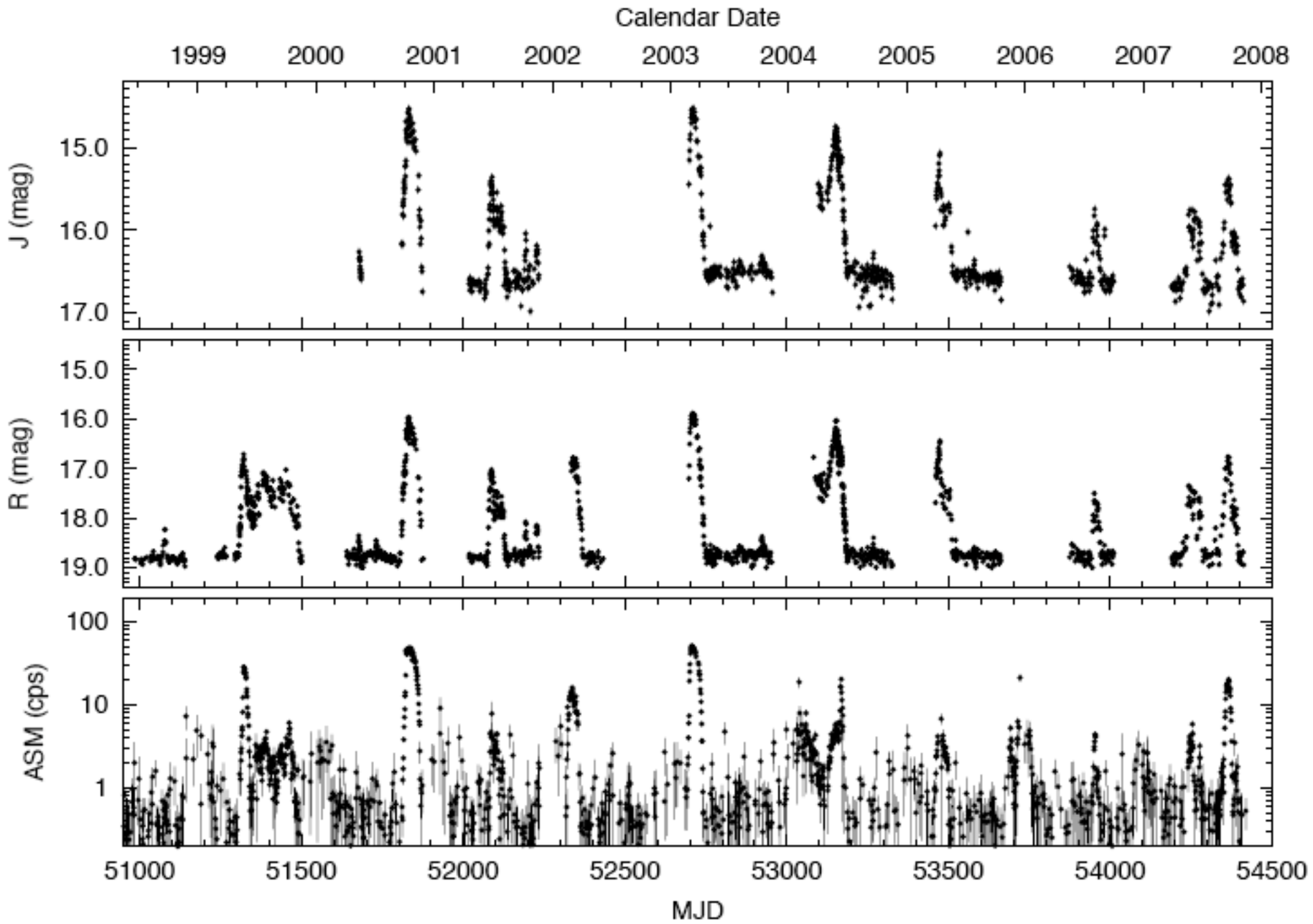


# X-ray binaries



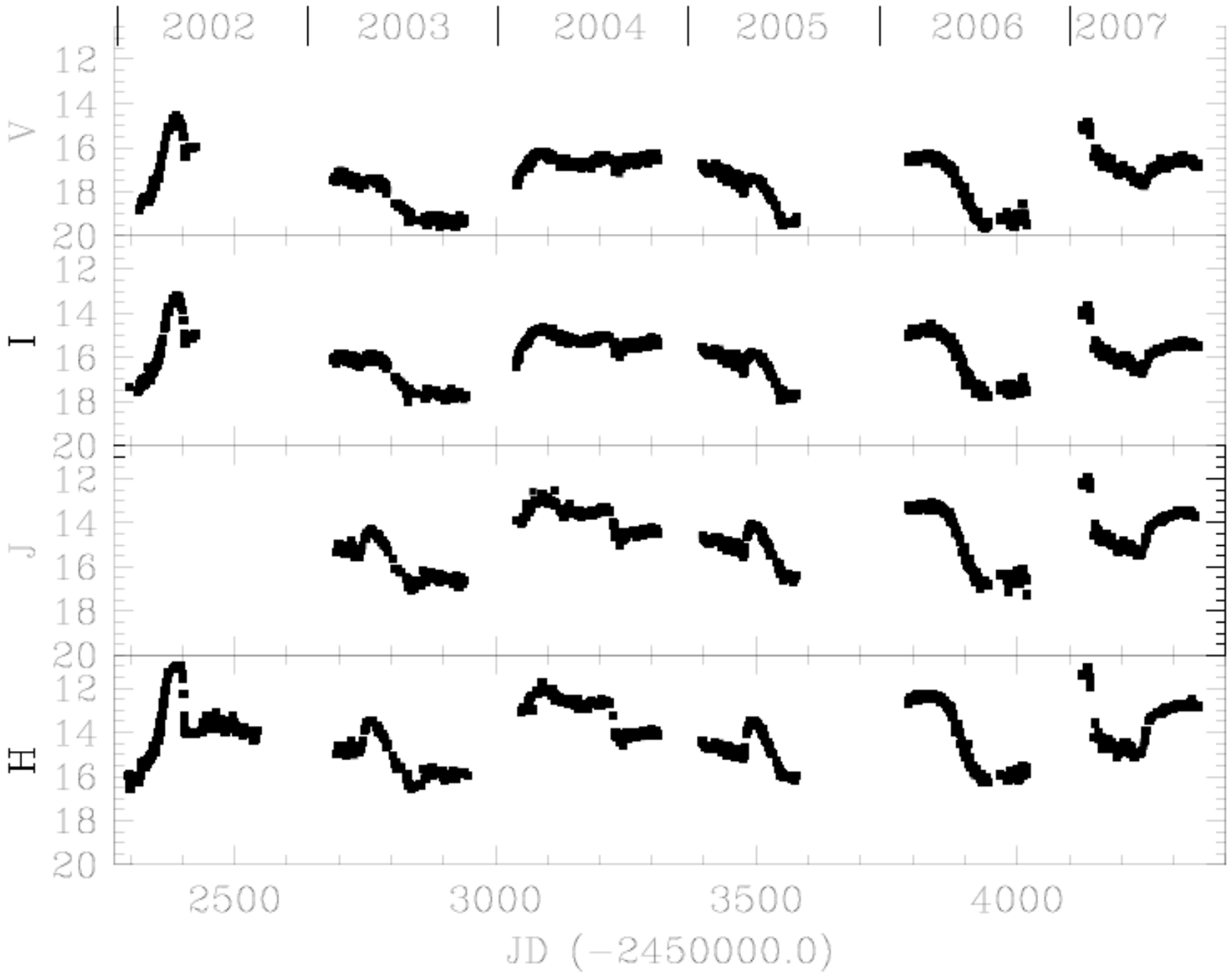



# Neutron stars: soft x-ray transients



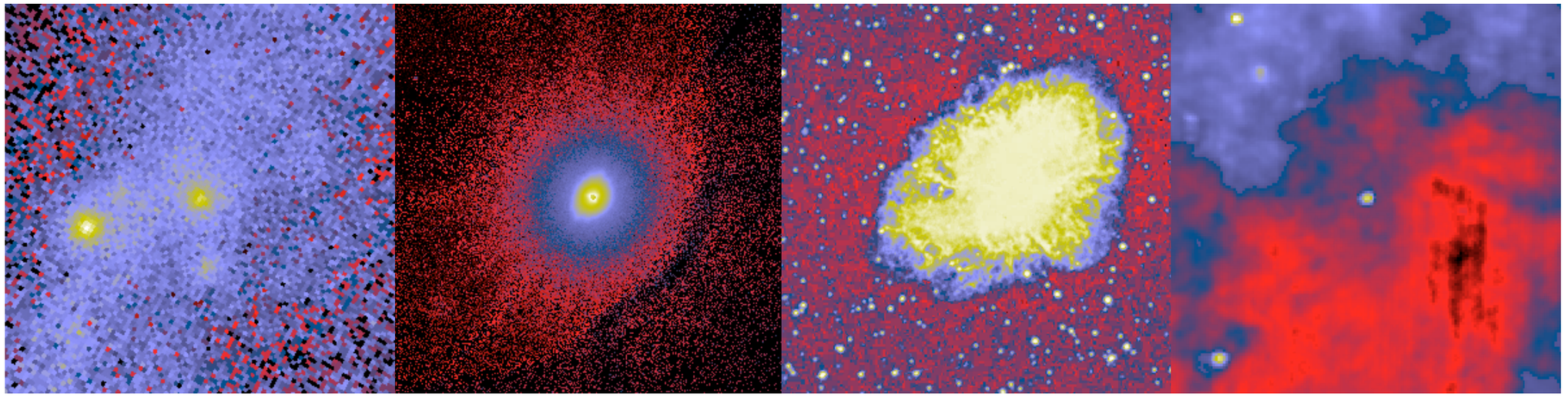

neutron star soft X-ray transient binary system Aql X-1 since 1998.

# black hole candidates

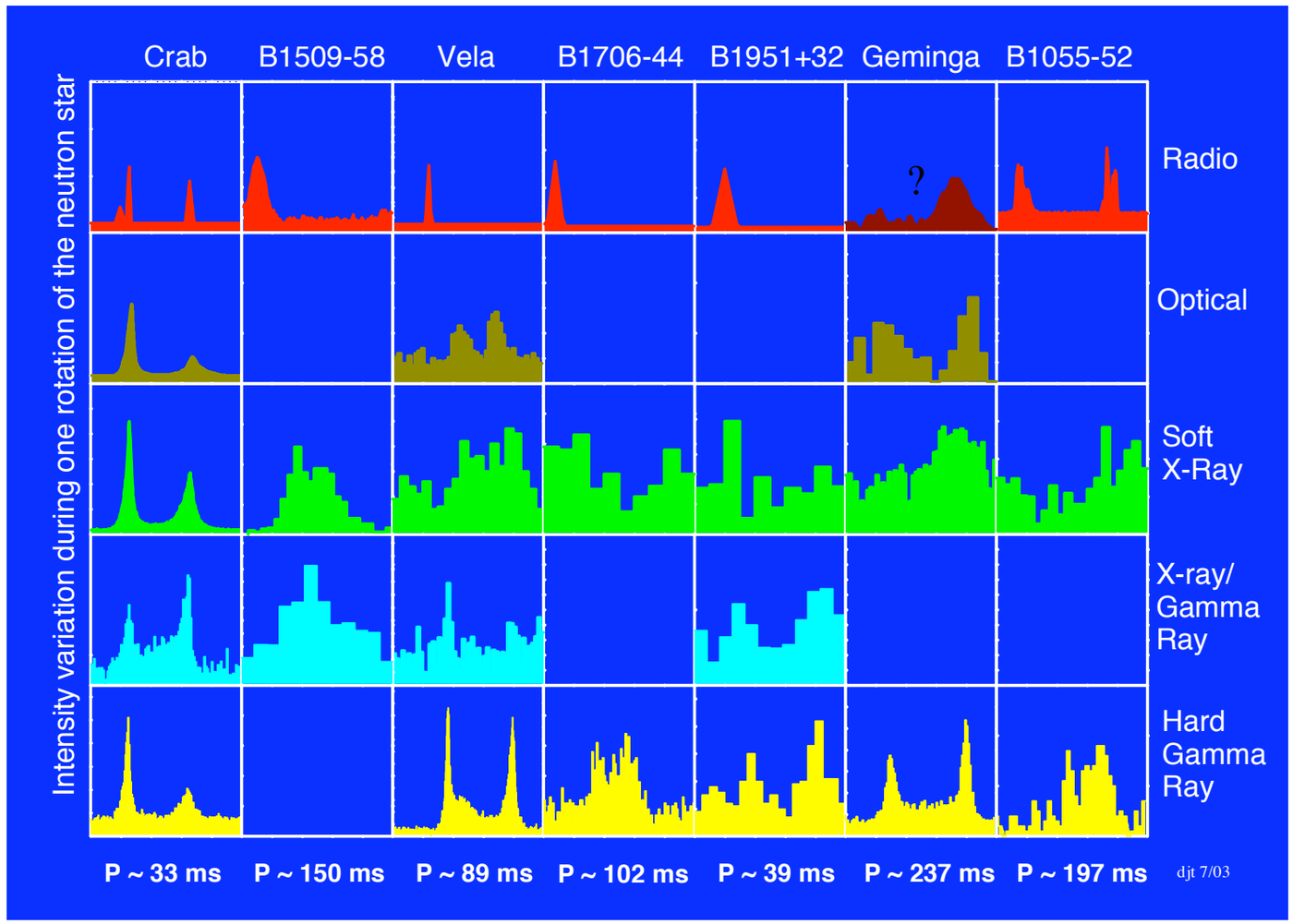



Long-term monitoring of the black hole candidate GX 339-4

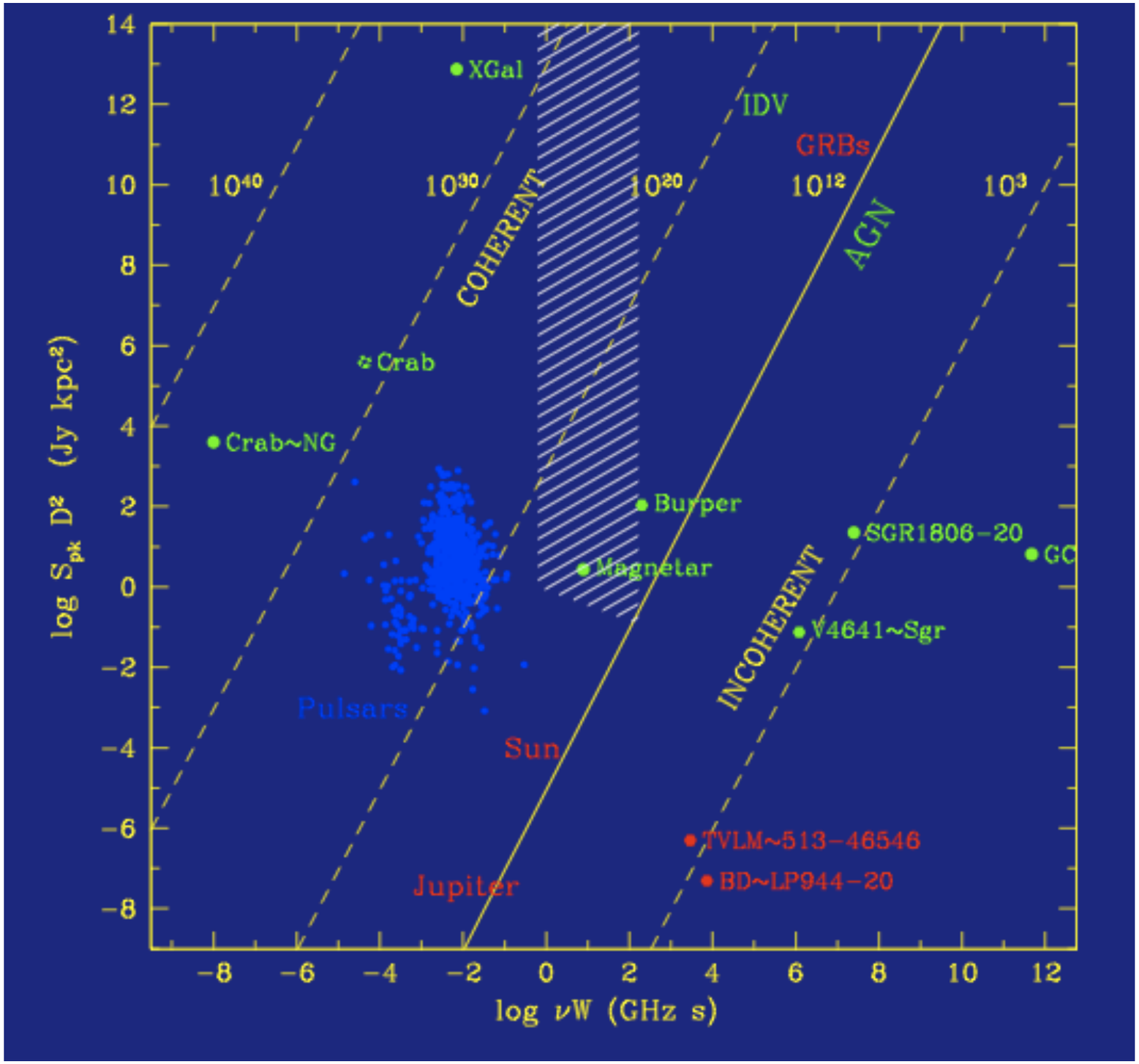
# Pulsars



Crab



# Panchromatic!

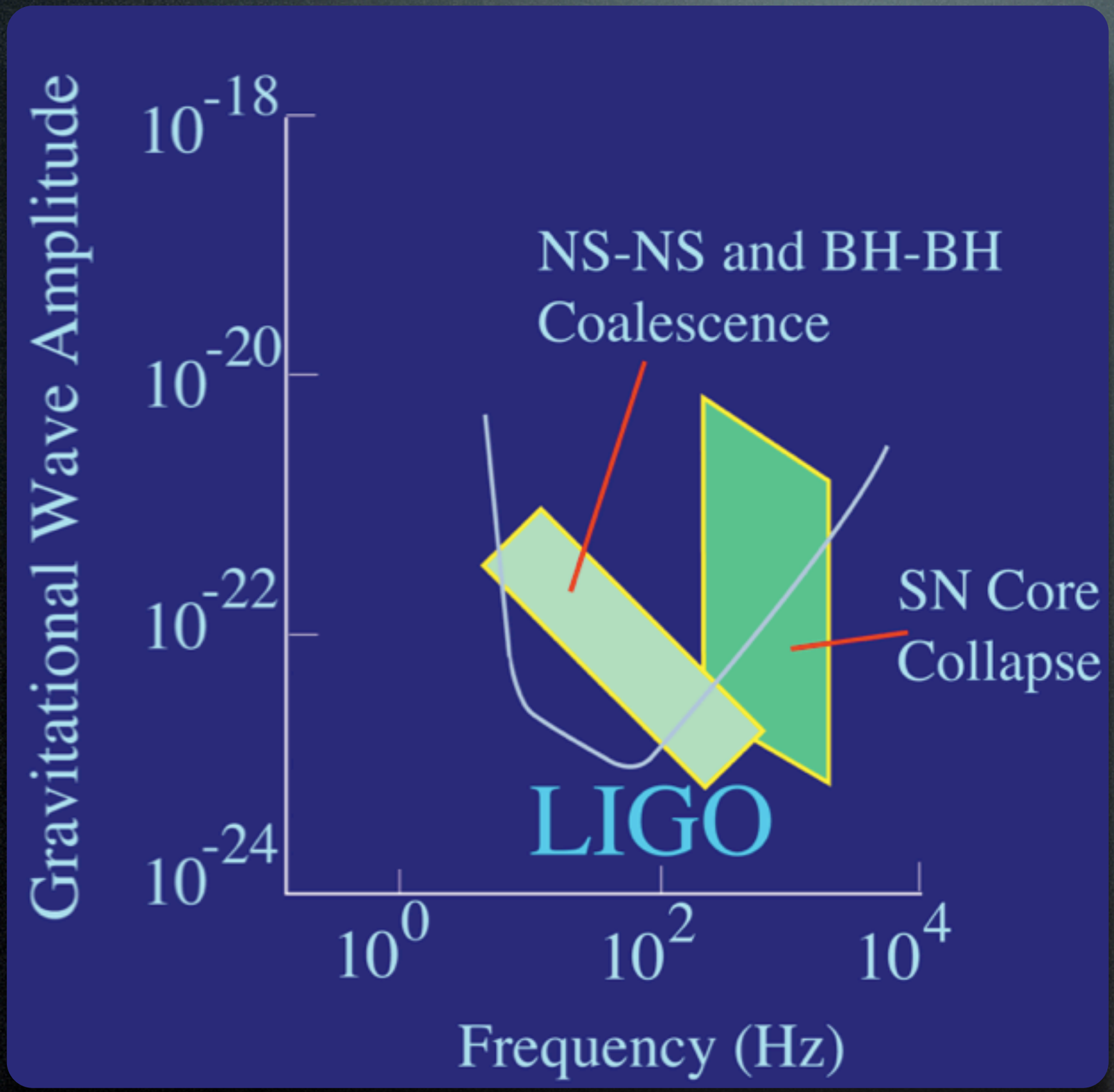


# Gravitational Wave & Neutrino Follow-up

*E&M connection to the next generation observatories*

e.g. LIGO-II to see NS-NS spiral > 100 Mpc
several tens event per year but with localization accuracy ~1 deg radius

SASIR: unique FOV + aperture, well-suited to rapid follow-up




Advanced LIGO (2009): If we have a nearby event from a NS binary, we should hear it!

# Serious Design Issues & questions

- construction of a 6.5m + primary (+secondary?) with **fast optics** (f/2.5) & wide FOV (~0.8 deg sq.)
- reduced radiative heat load for IR
- **cadences**: many surveys in one ("shallow", "medium", "deep") to accommodate science
- data flow, data serving

# Serious Design Issues & questions