



White Dwarf Explosions, Hypervelocity Stars,  
and the Accelerating Expansion of the Universe

Ken Shen (UC Berkeley)



## **Core collapse supernovae**

(Type II, Type Ib, Type Ic)

Gravitational collapse of  
(initially) massive stars,  
>10x the mass of the Sun

## **Type Ia supernovae**

Thermonuclear explosions  
of white dwarfs

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SN 2011fe

06 Feb. 2011

The Virtual Telescope Project ([www.virtualtelescope.eu](http://www.virtualtelescope.eu))



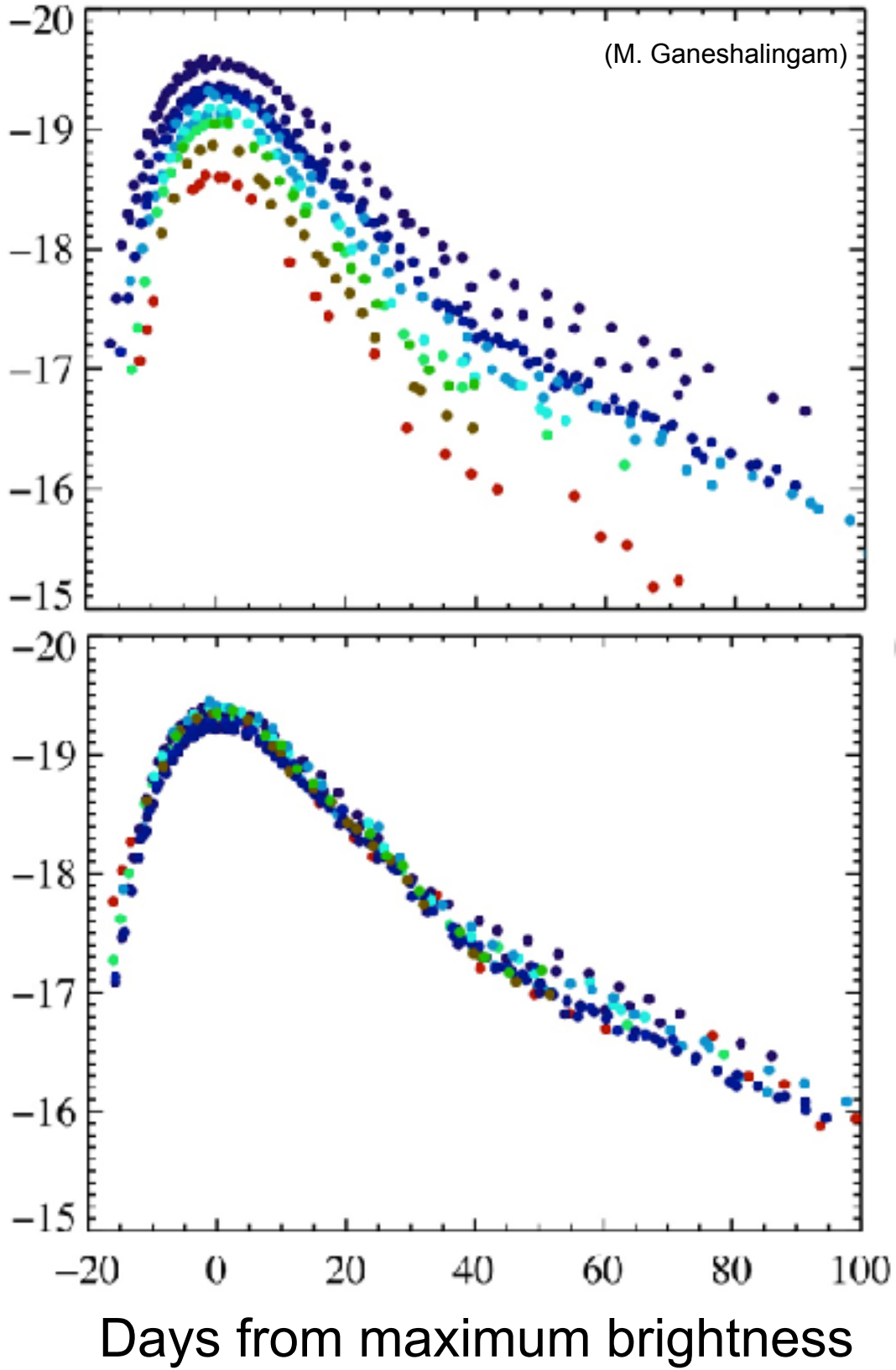
CORRECTED BRIGHTNESS →

BRIGHTNESS →

Corrected absolute

B-band magnitude

Absolute B-band magnitude



Earth

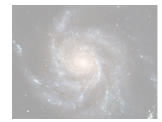
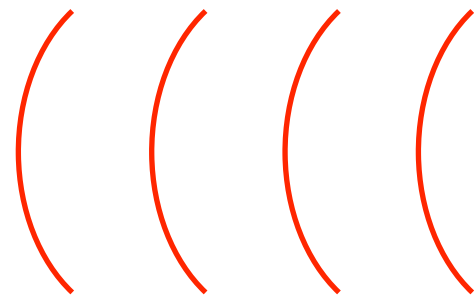
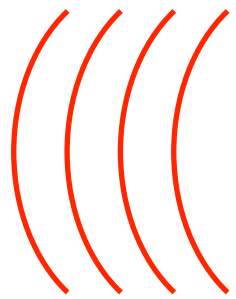


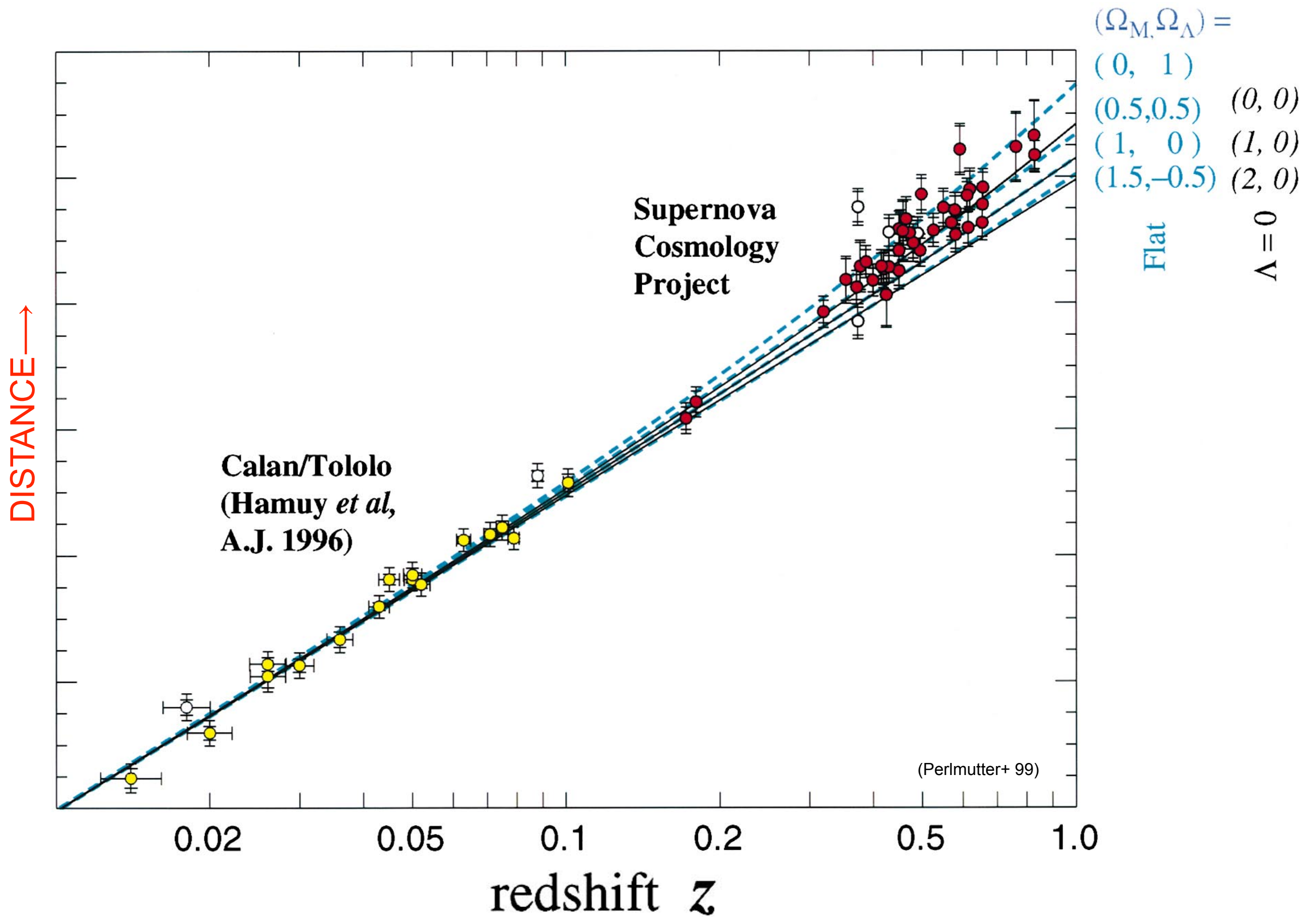
Longer wavelength  
Lower frequency

Shorter wavelength  
Higher frequency

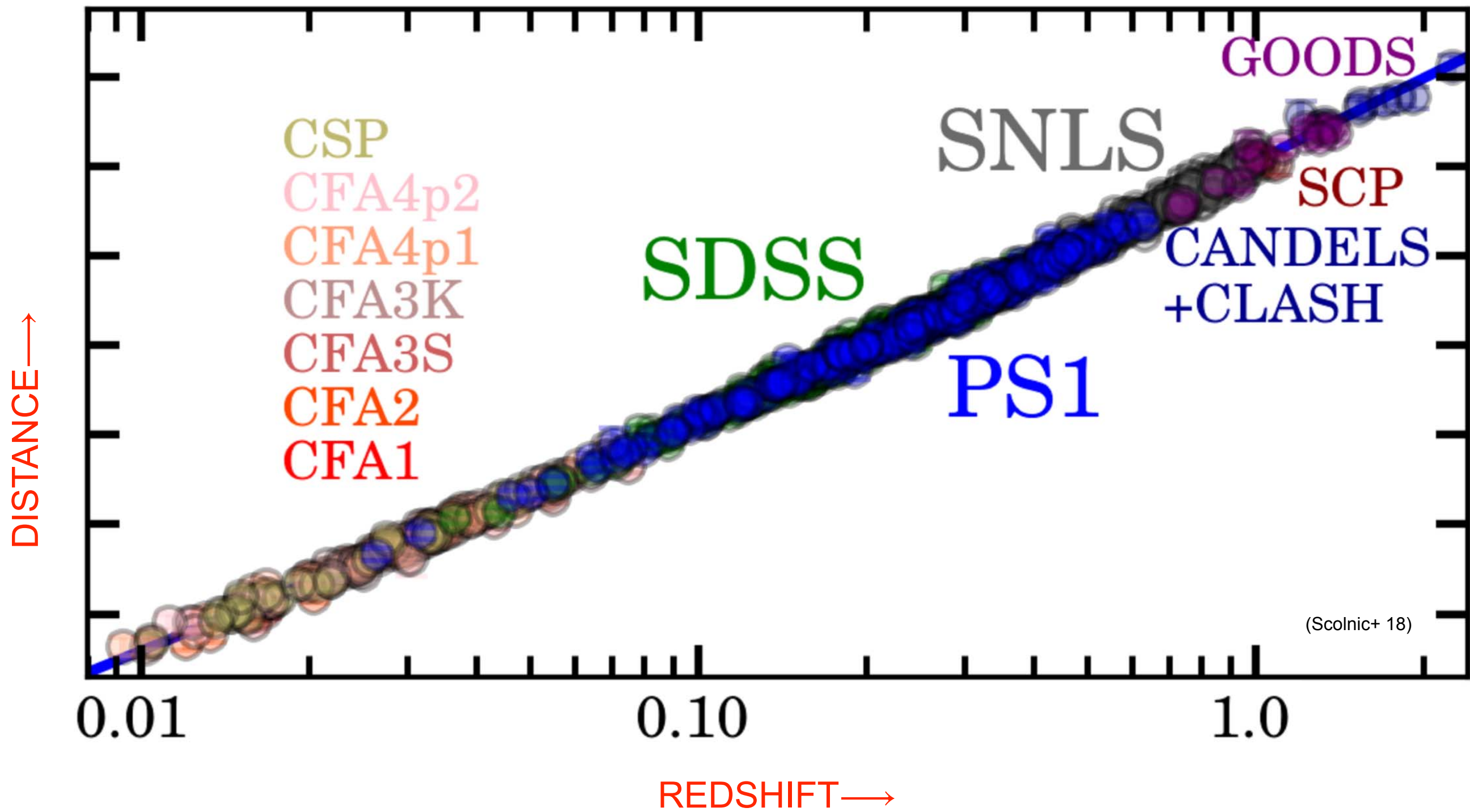


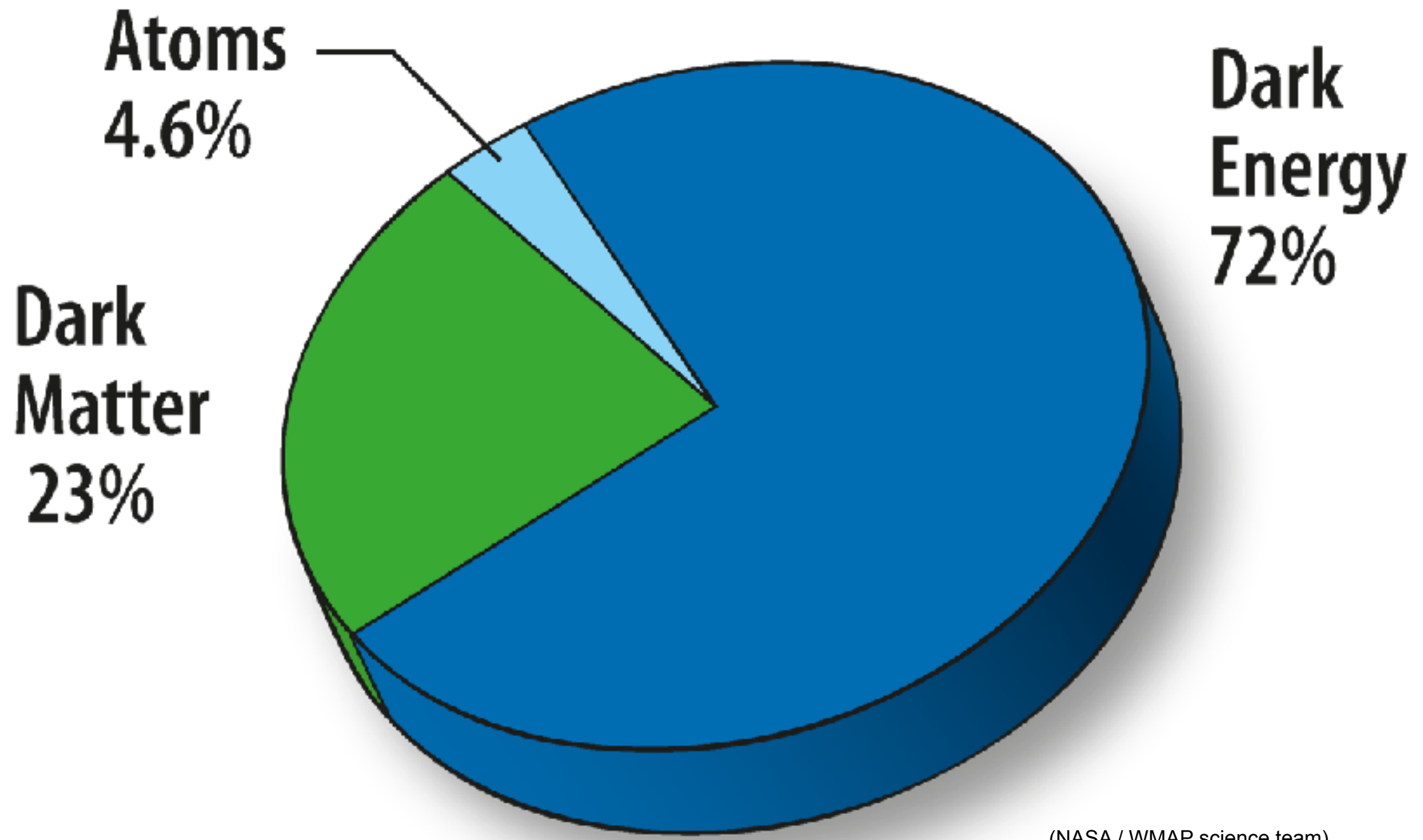












(NASA / WMAP science team)





Saul Perlmutter



Adam Riess



Brian Schmidt



(U. Montan)

Supernova Cosmology Project

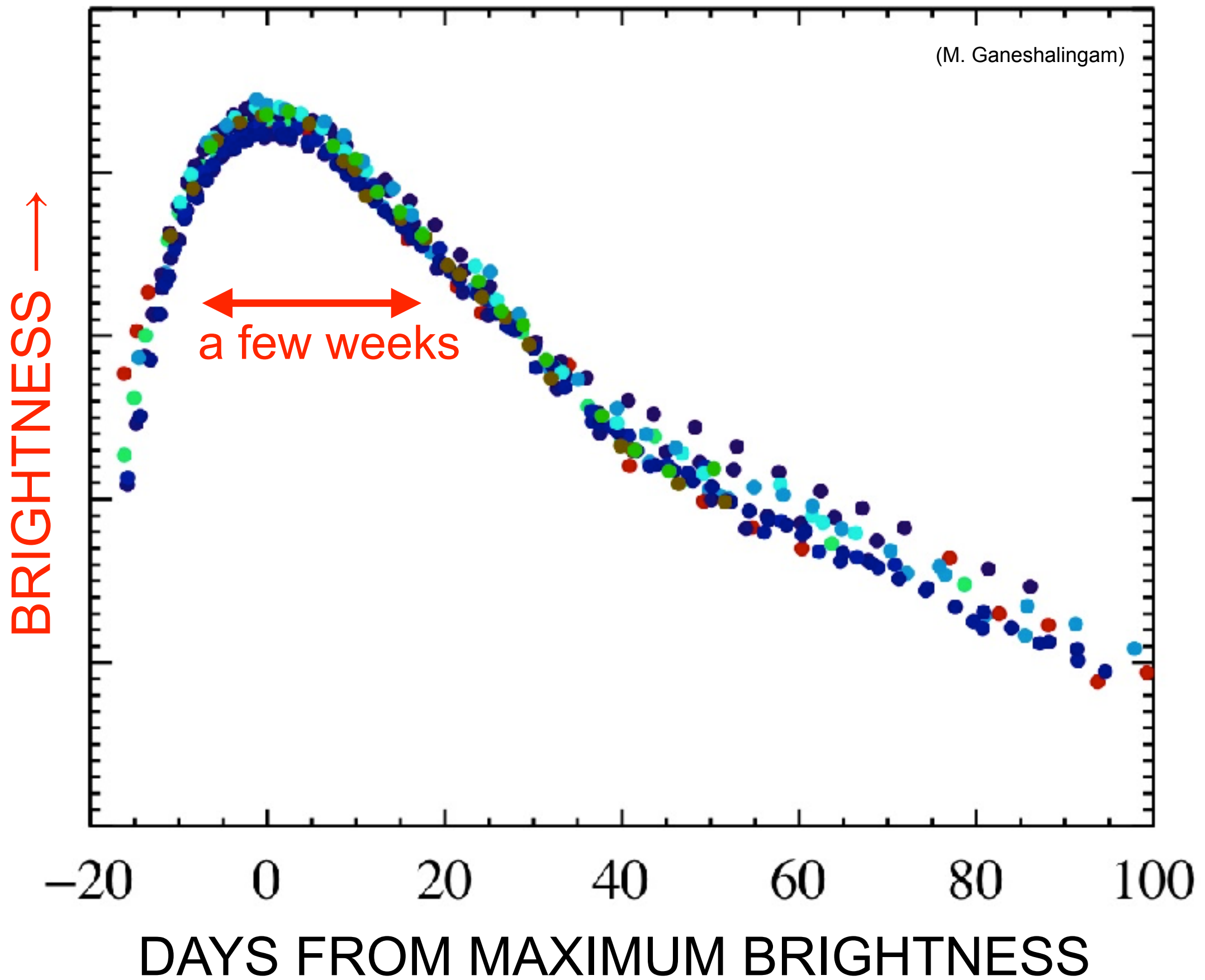


(R. Knop)

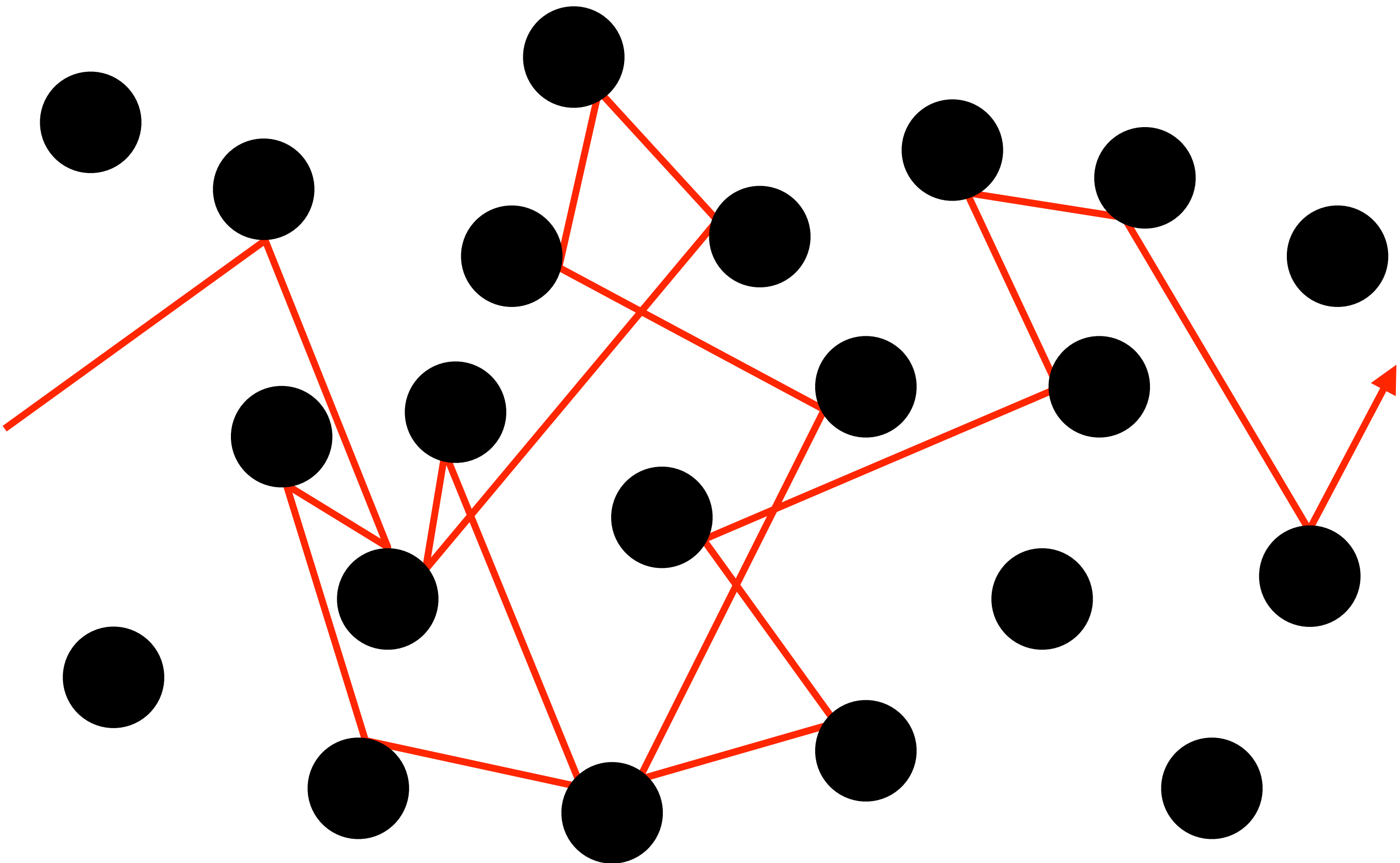
High-Z team

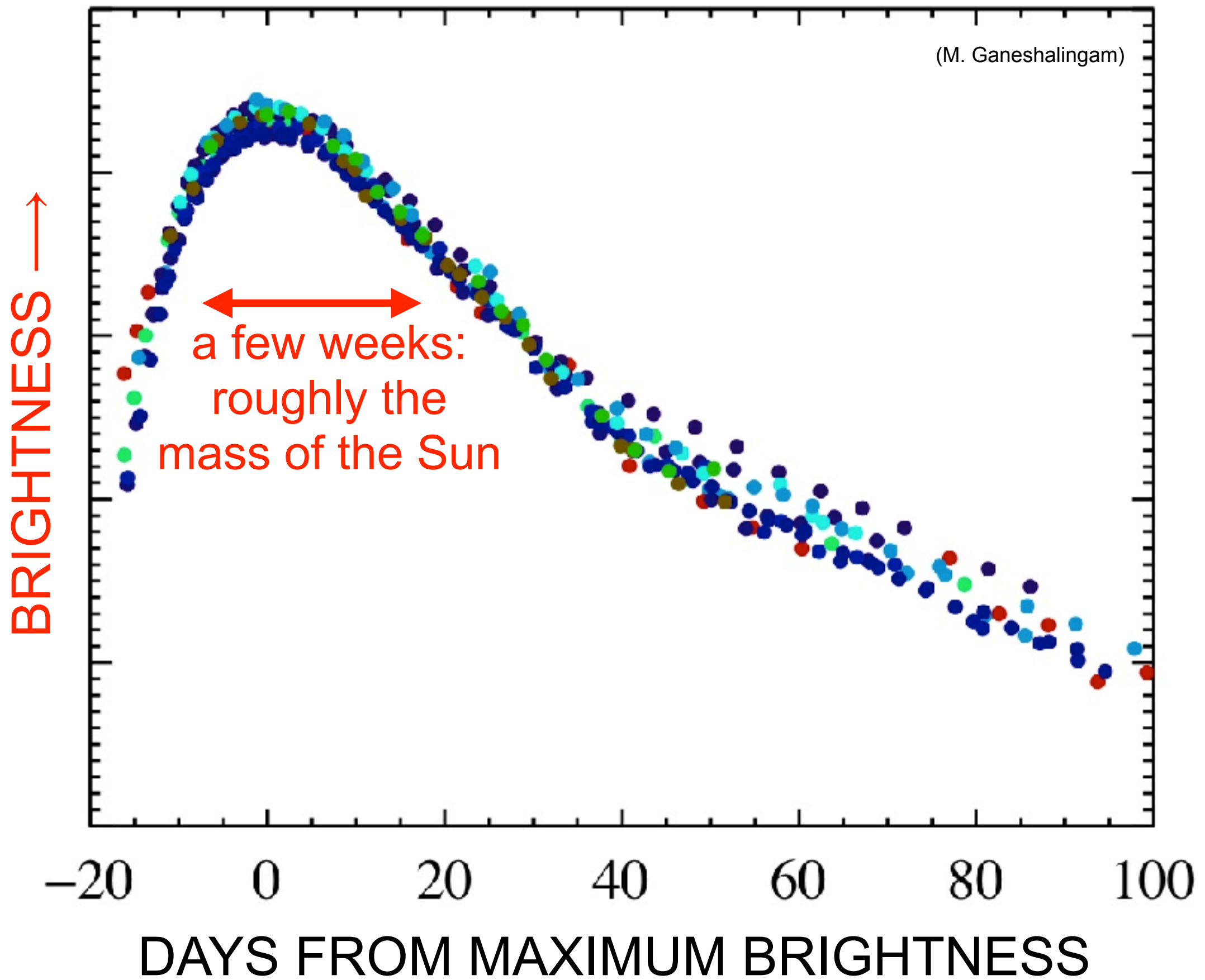


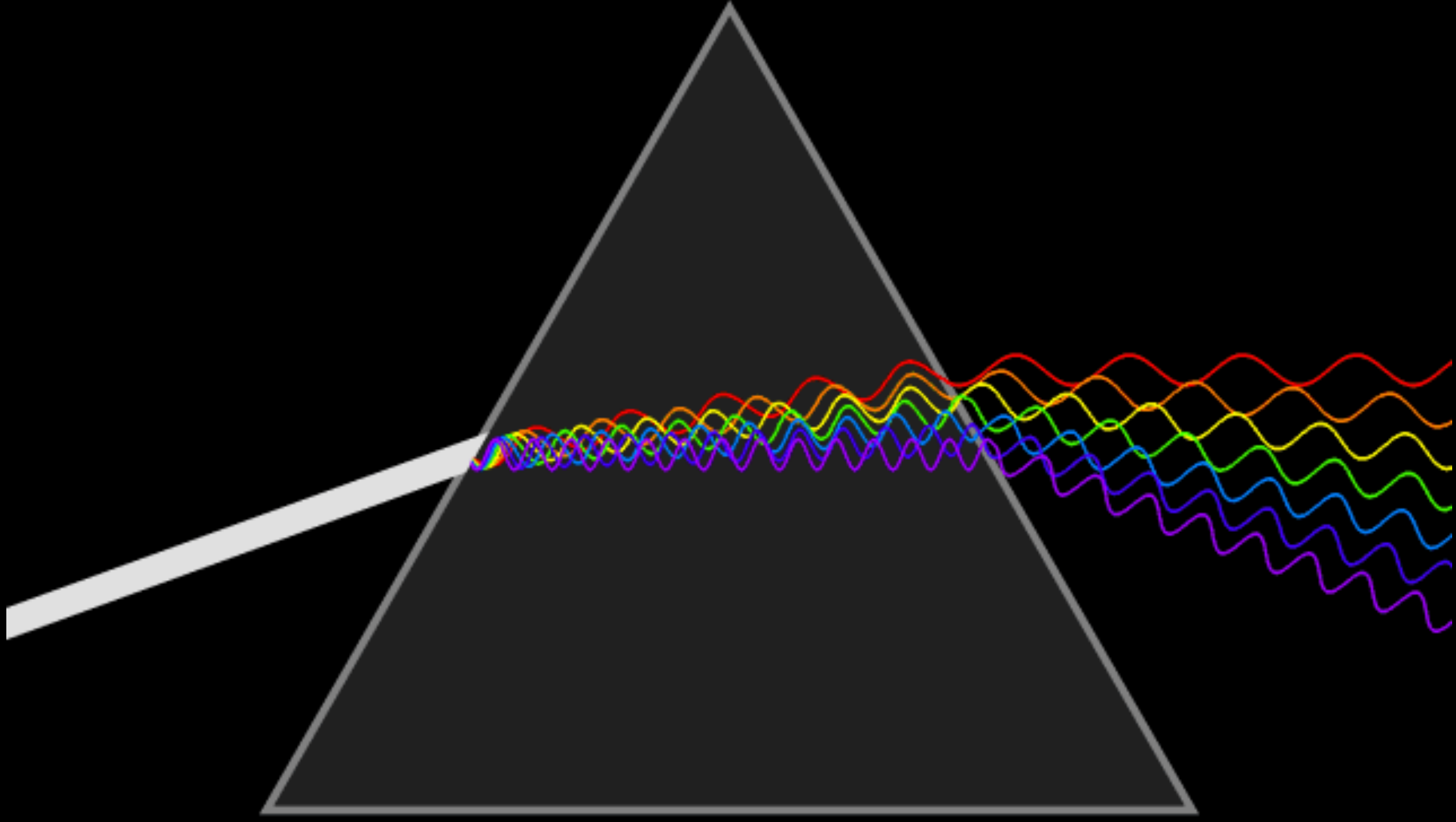
(cfa.harvard.edu)



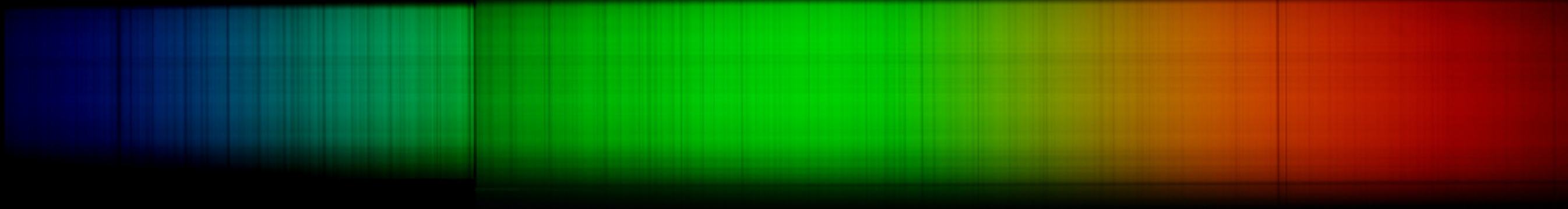




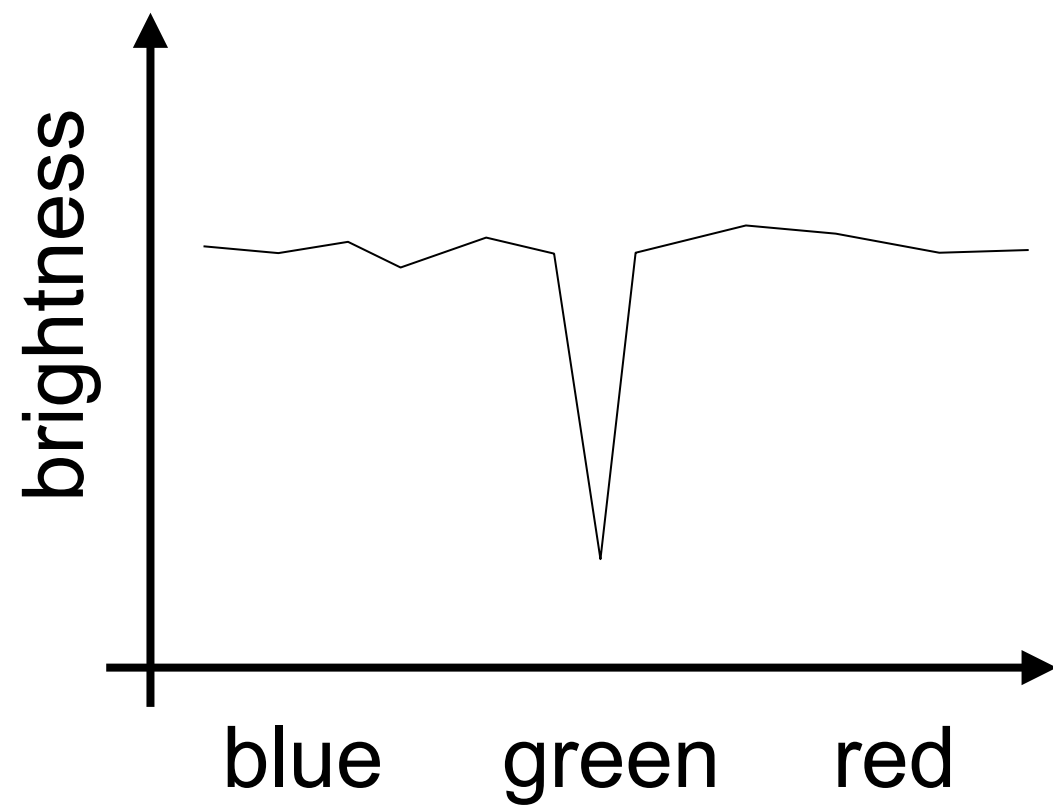
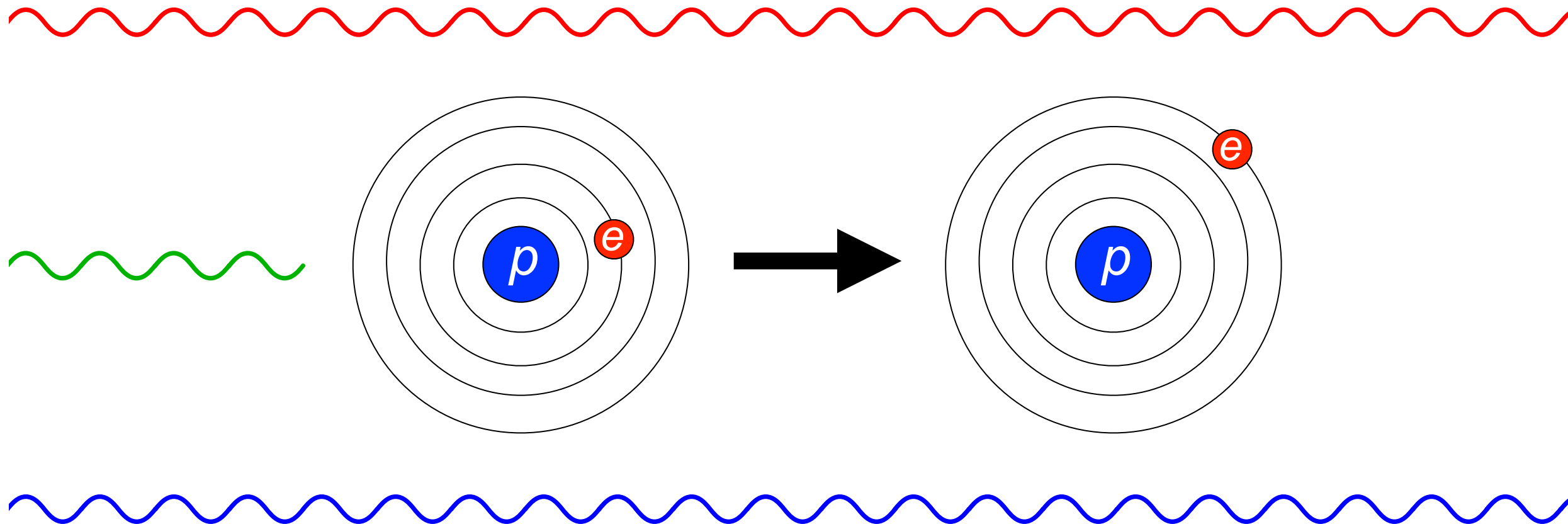




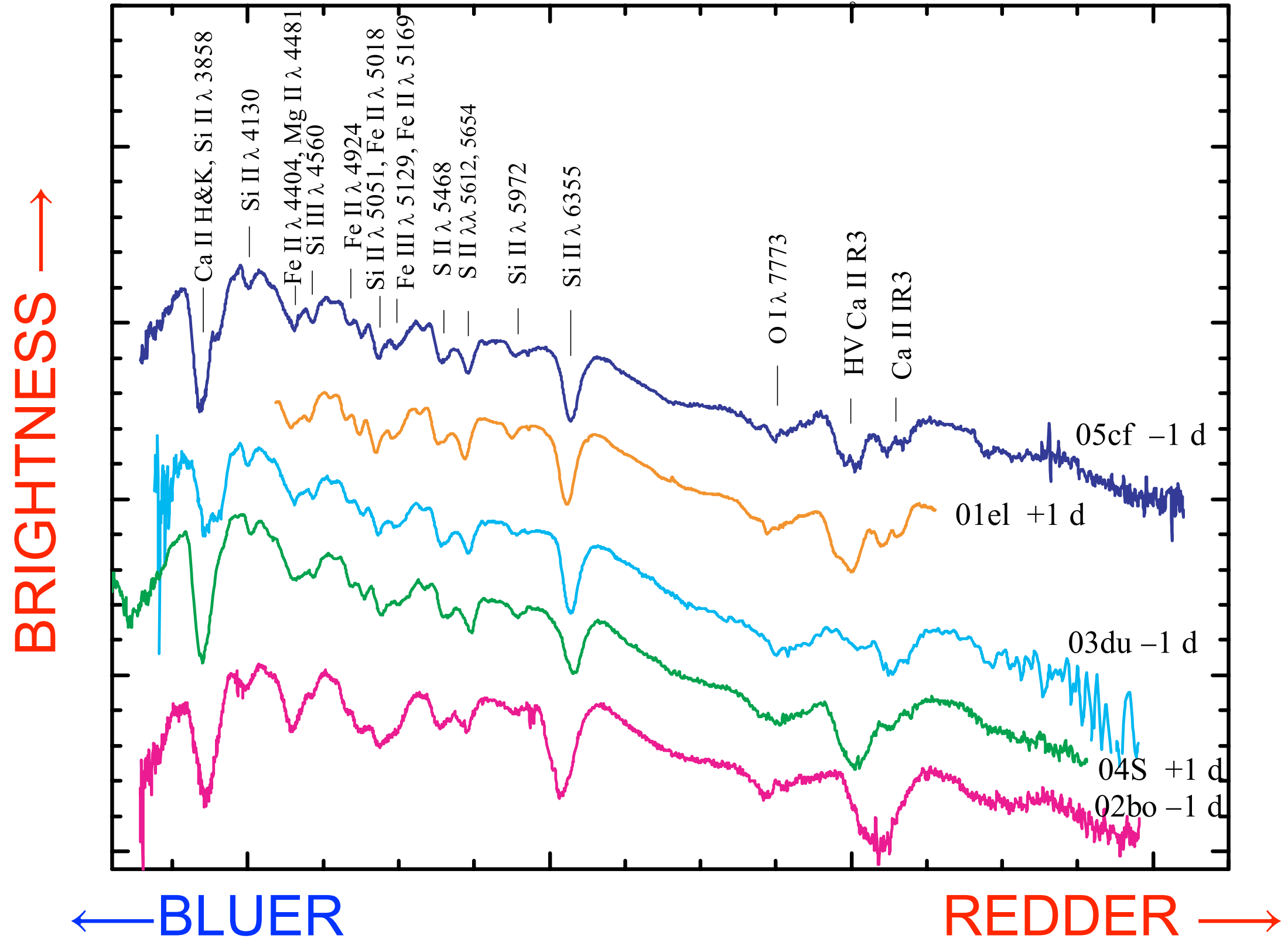




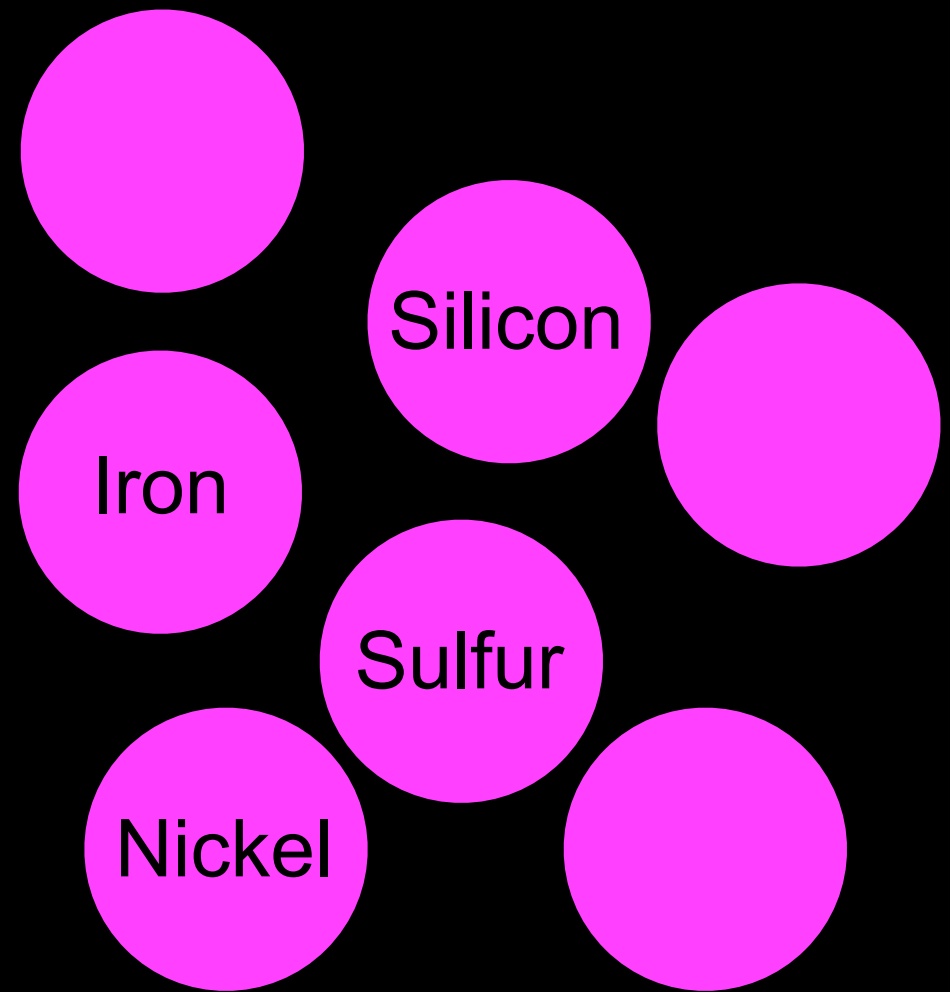
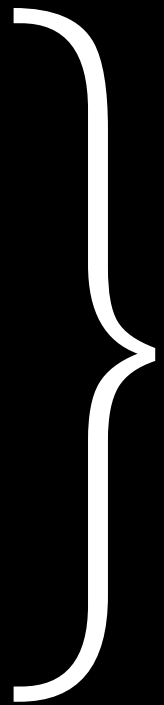
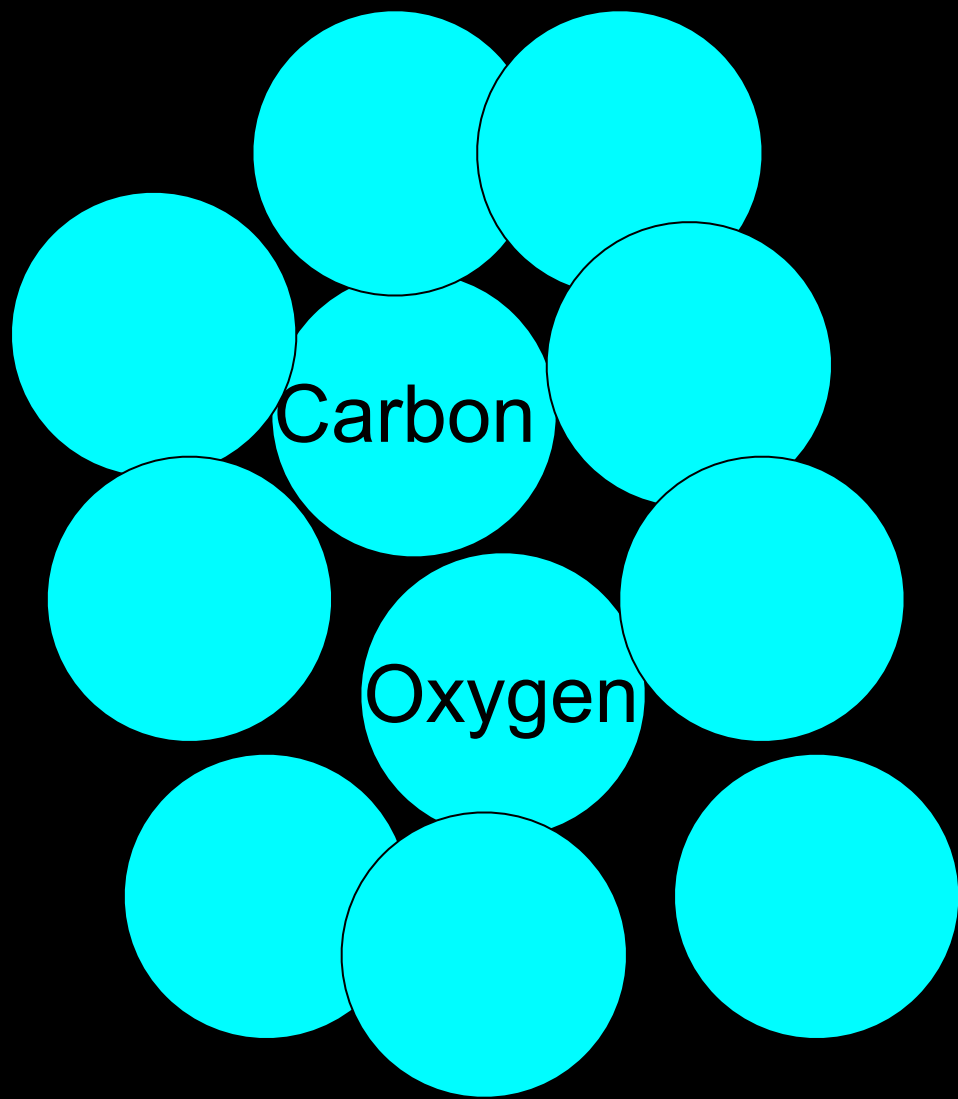
[bu.edu/astronomy](http://bu.edu/astronomy)

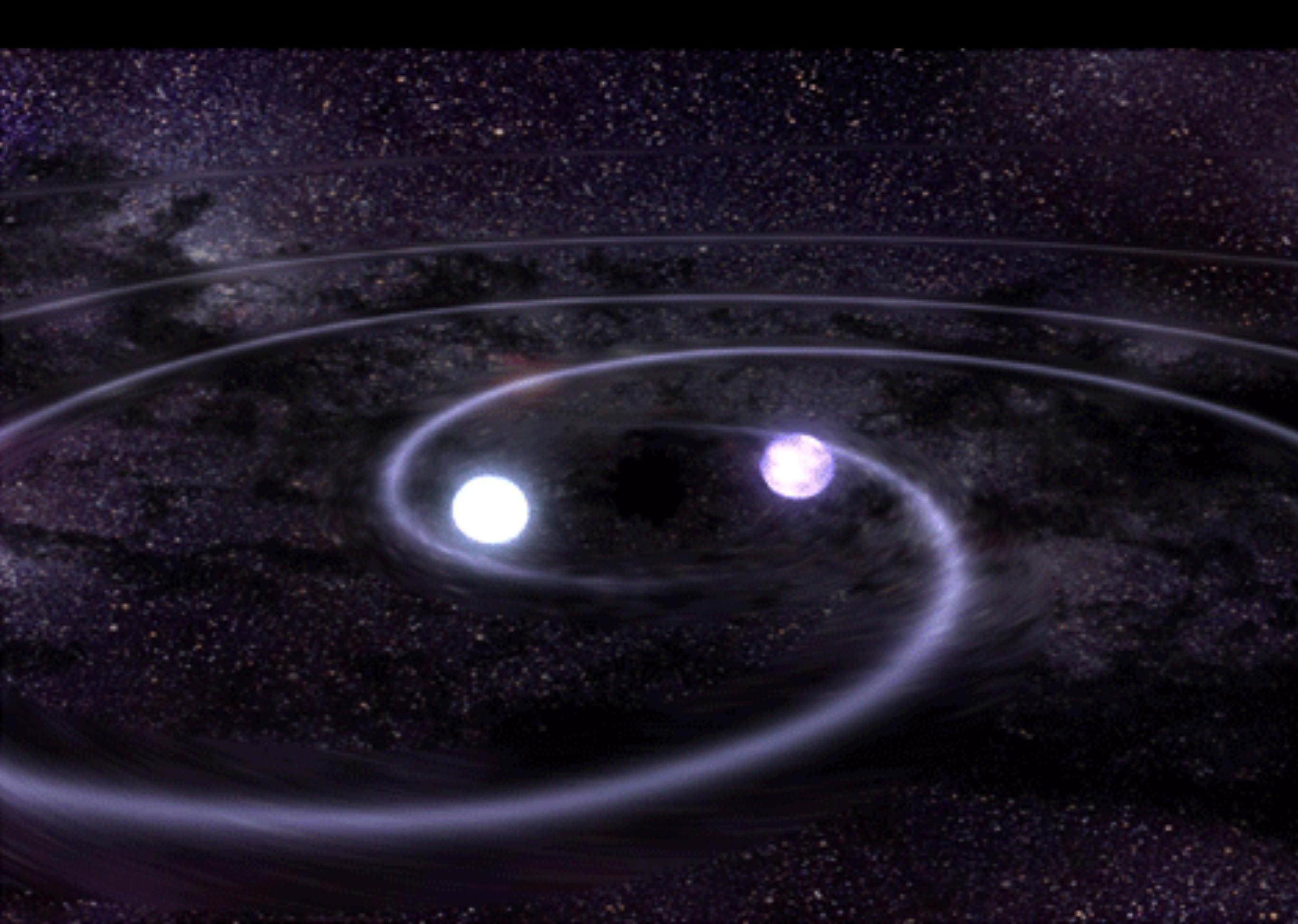


(Wang+ 09)

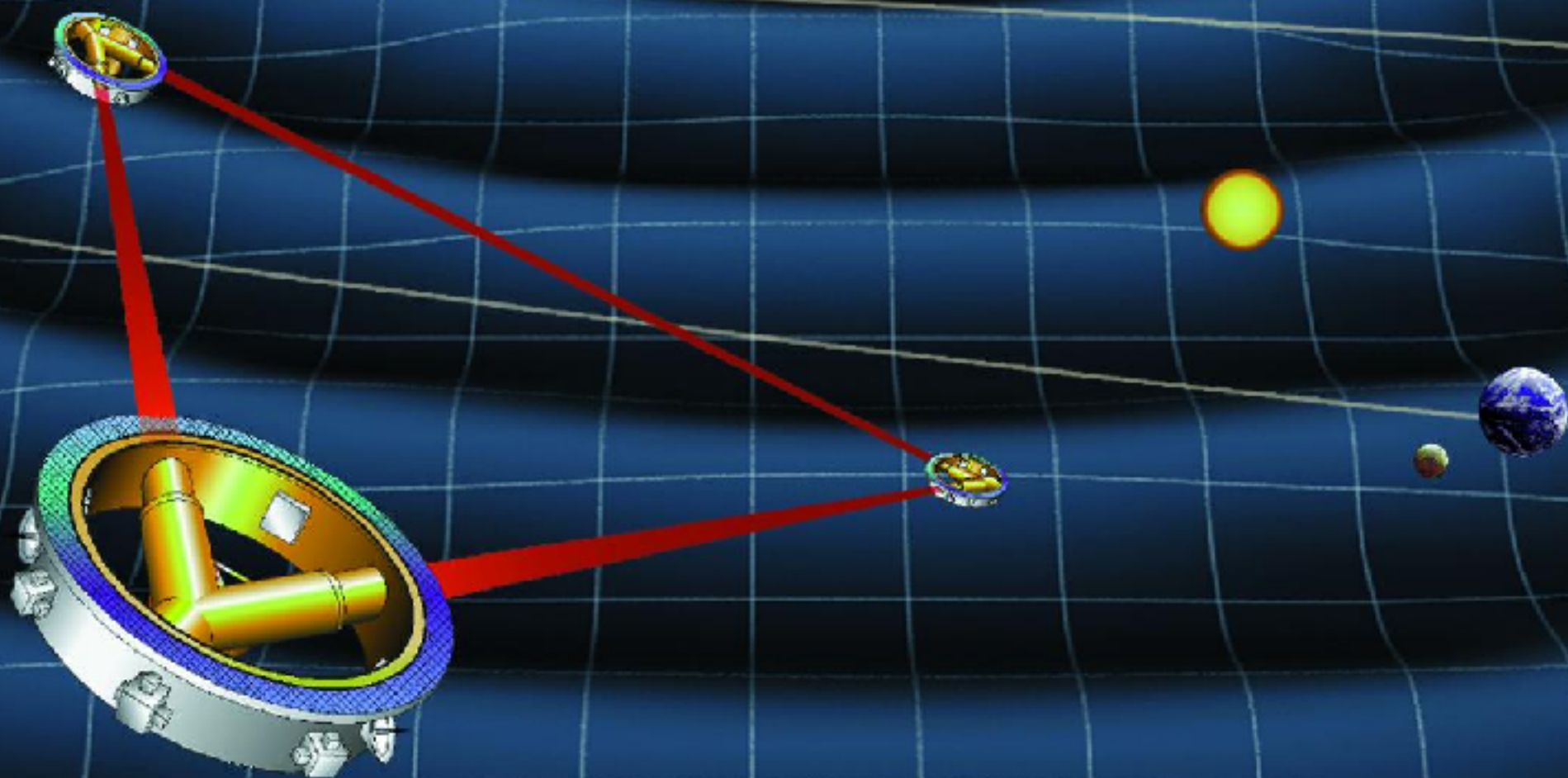
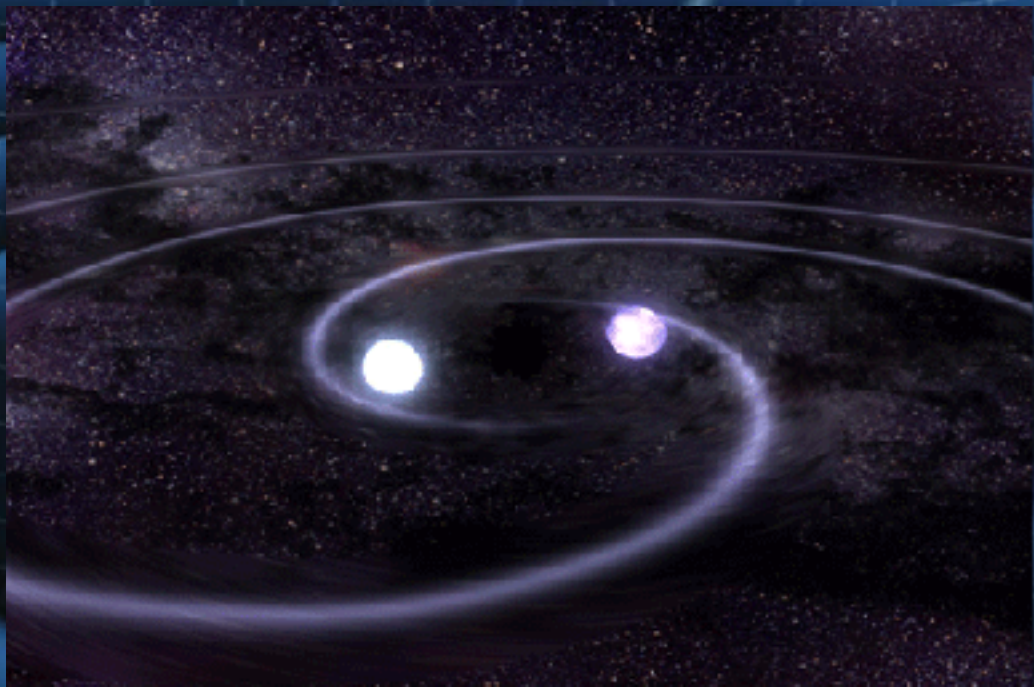




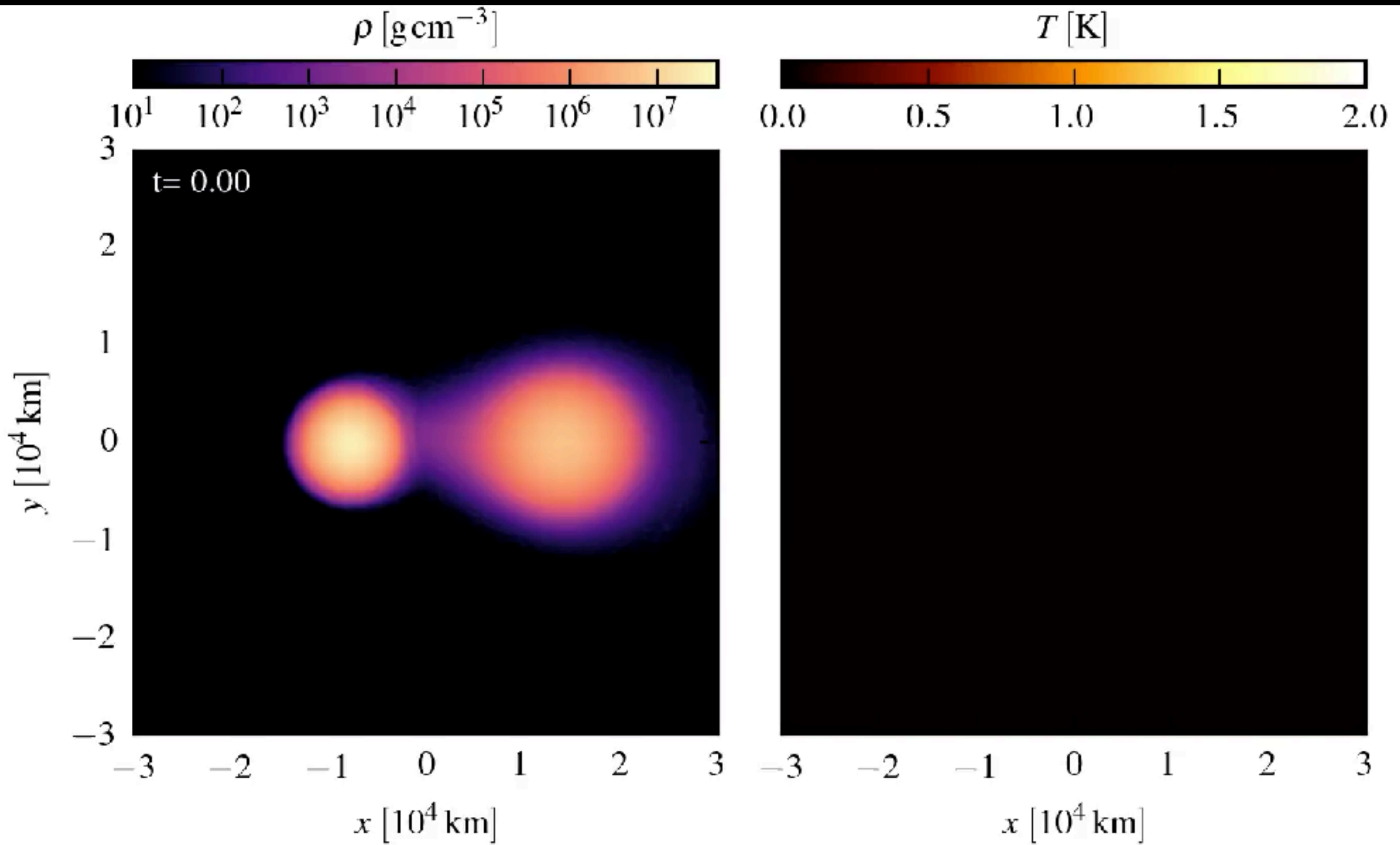


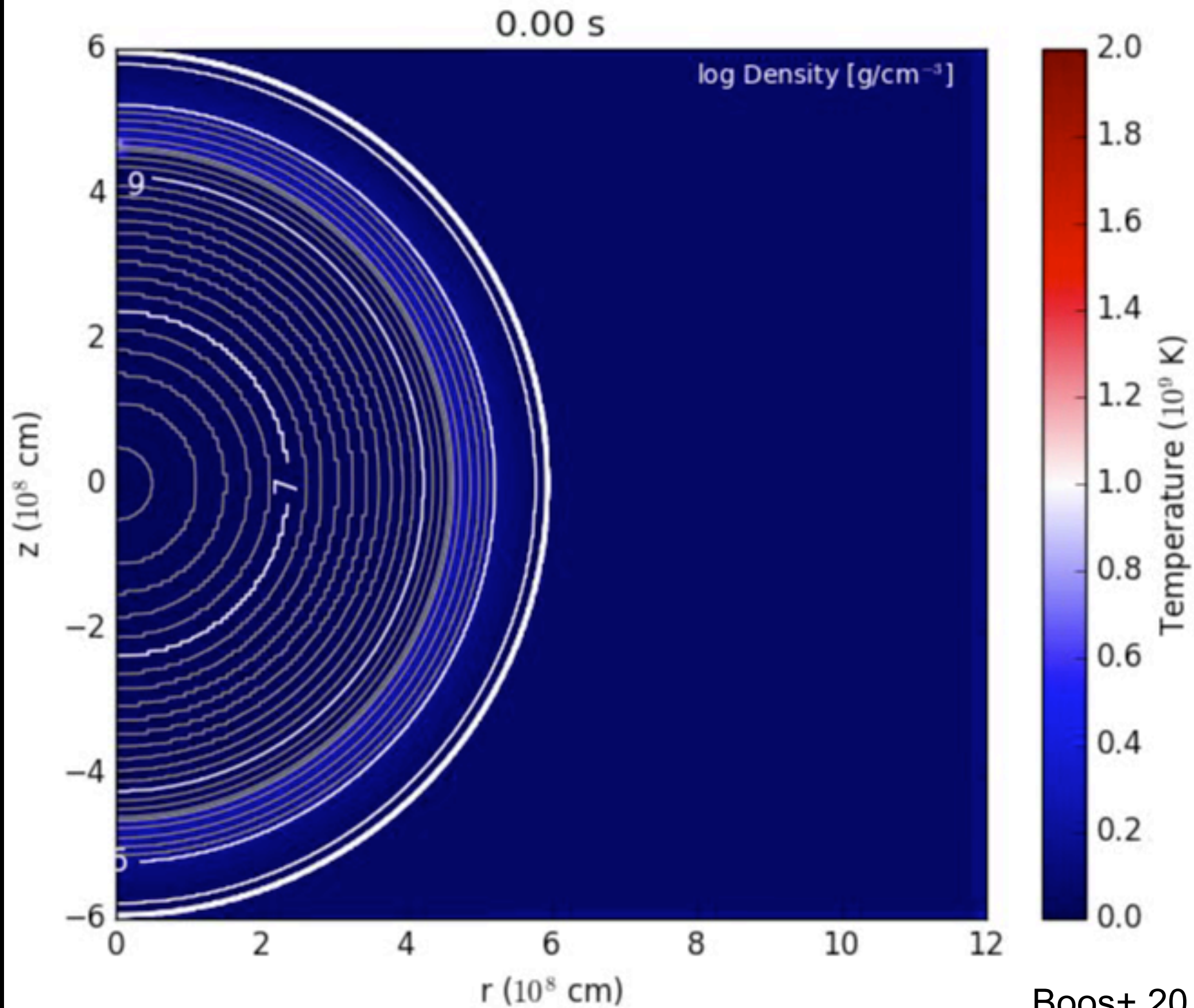








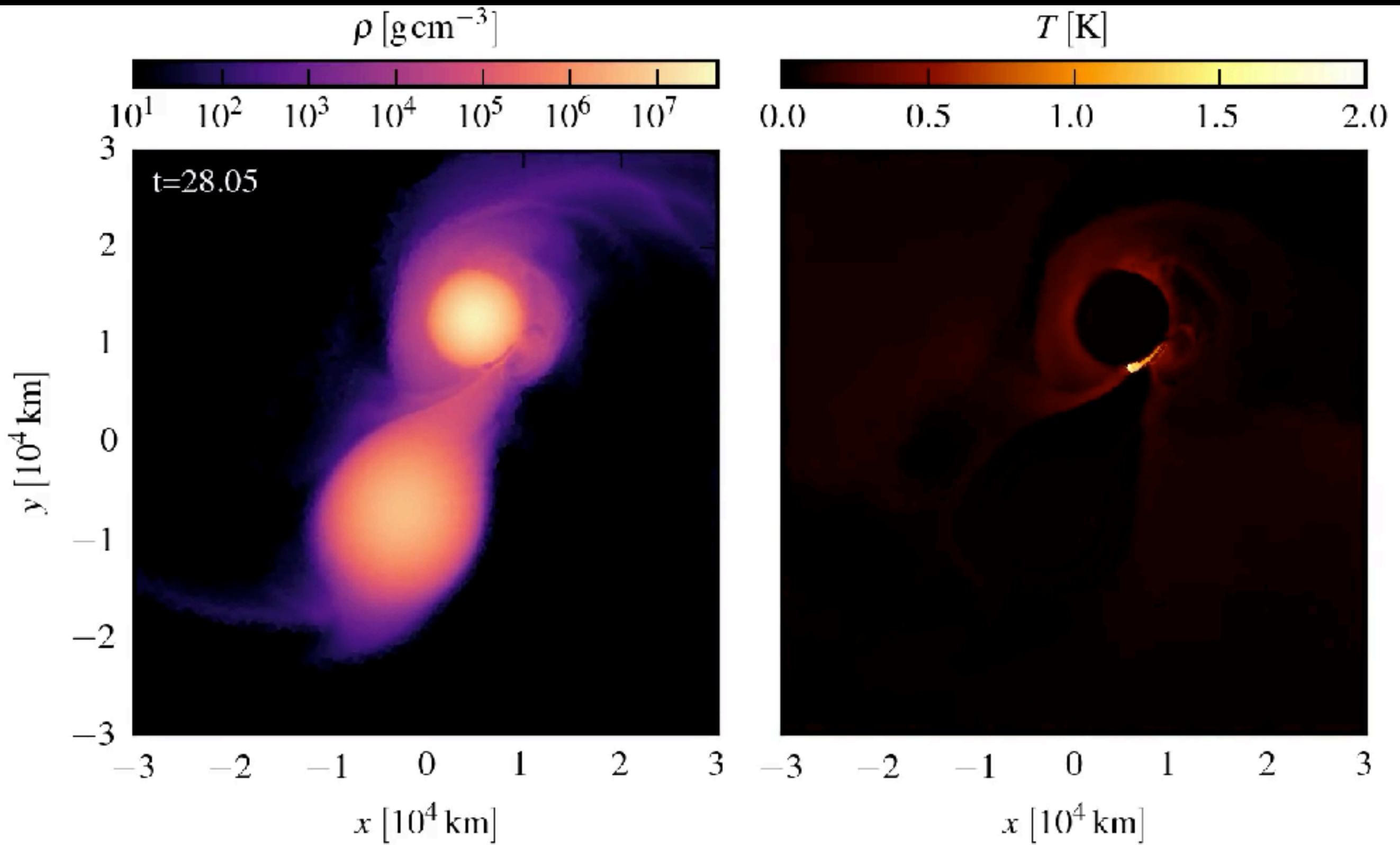


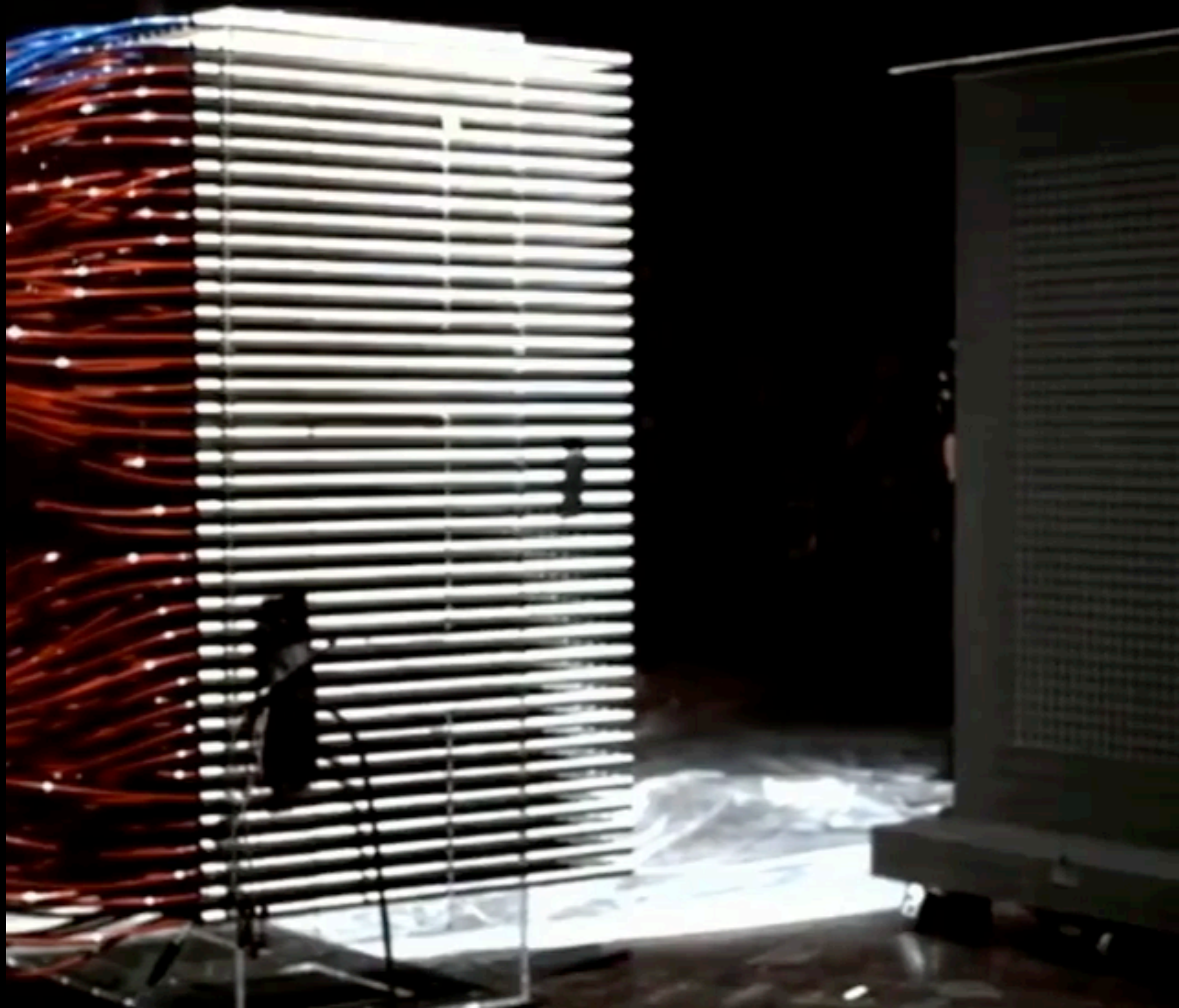




M. Versluis





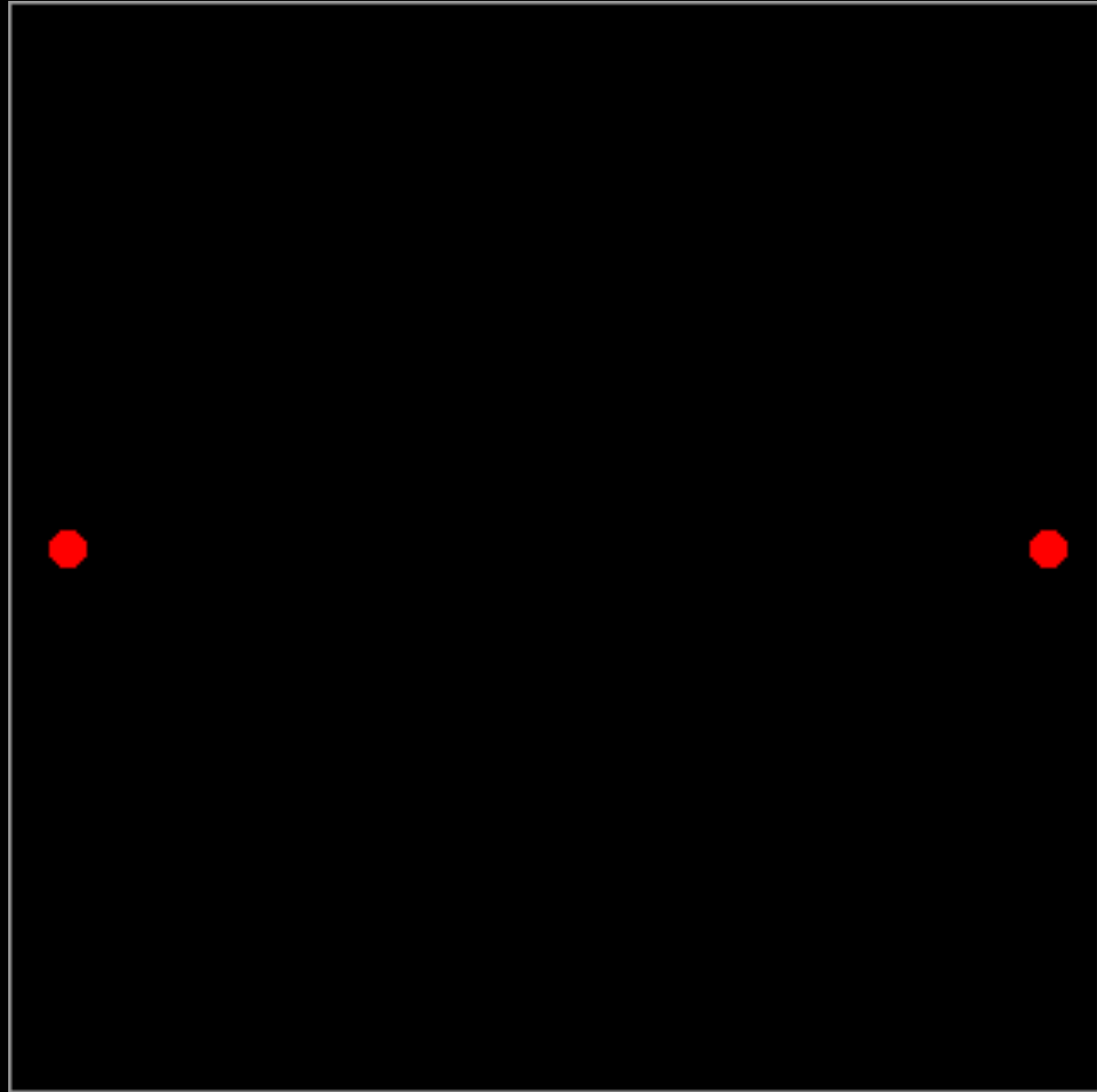




A large, round cake is the central focus, completely covered in white frosting and a dense layer of multi-colored sprinkles. The sprinkles are in various colors including red, blue, yellow, green, pink, and orange. The cake is set against a light blue background. A black rectangular box with white text is overlaid on the center of the cake.

**surviving white dwarf covered  
in thermonuclear ash**























**2500 km/s = 1% the speed of light!**

- **Berkeley - NY in < 2 seconds**
- **Earth to Moon in 2.5 minutes**
- **ejected from the Milky Way in 4 million years**
- **could reach Andromeda in 300 million years!**



# Three Hypervelocity White Dwarfs in *Gaia* DR2: Evidence for Dynamically Driven Double-degenerate Double-detonation Type Ia Supernovae

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- **We found 3 stars with the right speeds (>1000 km/s) and compositions (covered in thermonuclear ash)**
- **And one points back to the remnant of a supernova!**
- **But do all Type Ia supernovae happen this way?**
- **And are there subtle effects that might change cosmology results?**