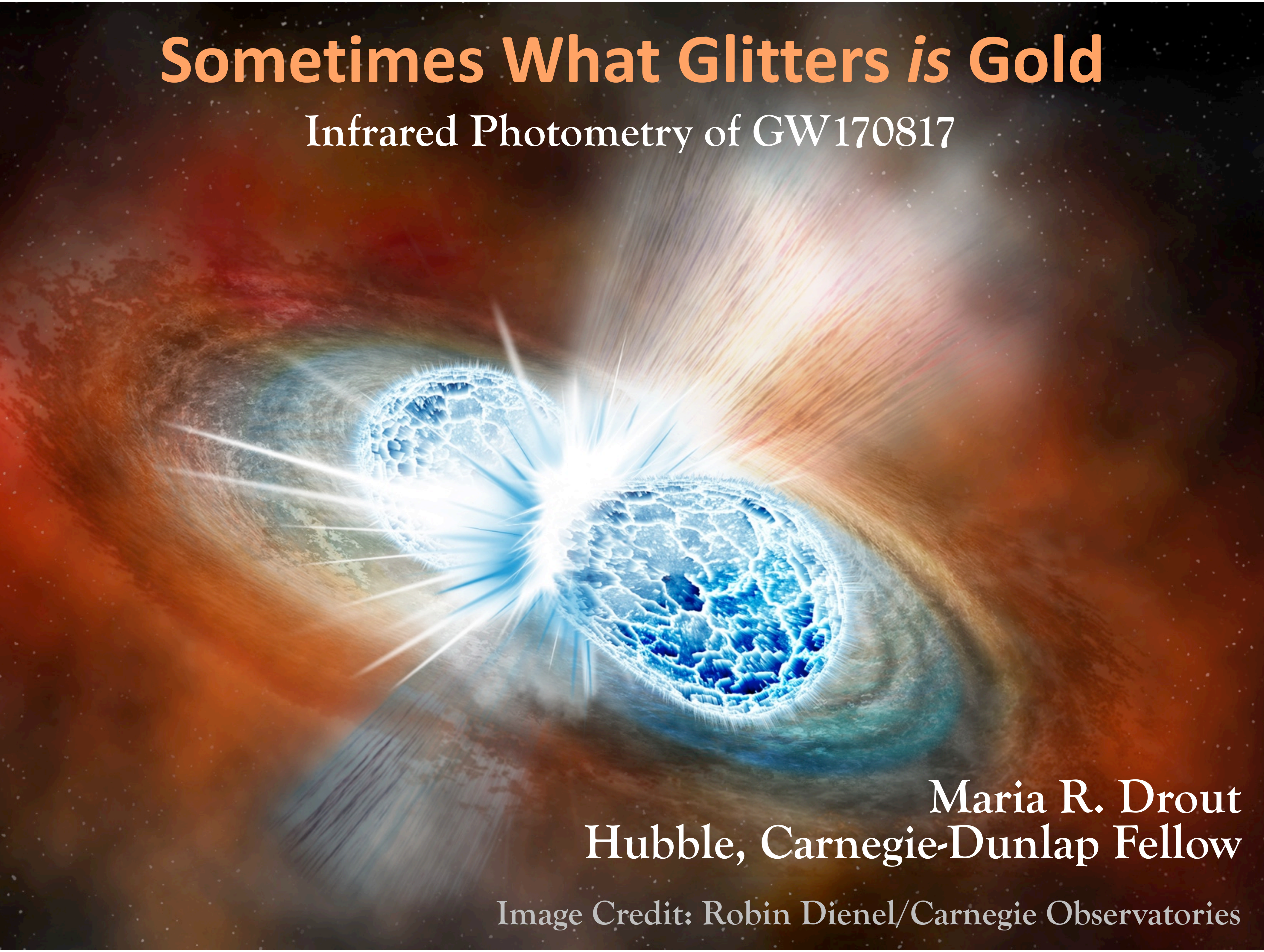
Sometimes What Glitters *is* Gold

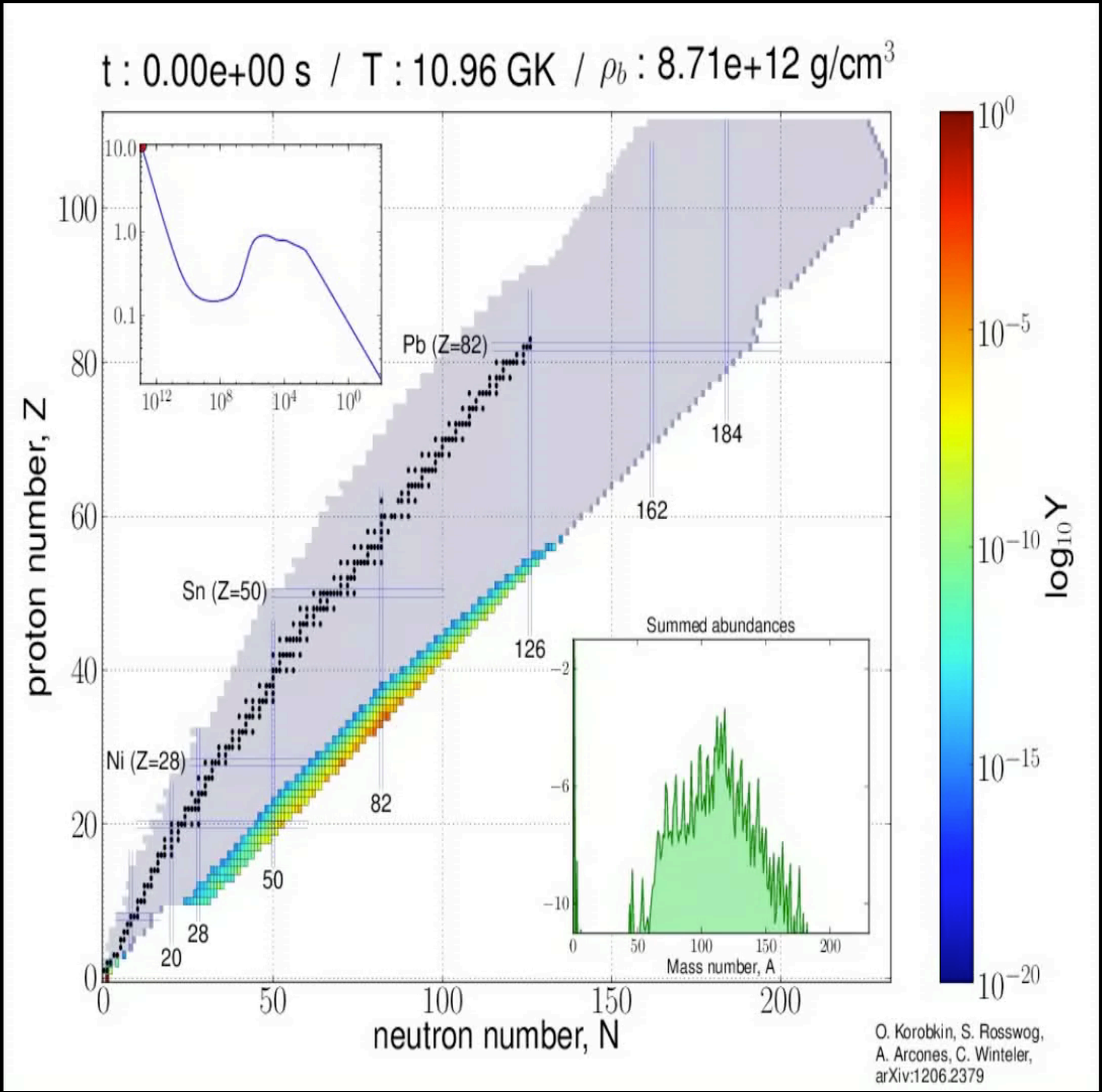
Infrared Photometry of GW170817



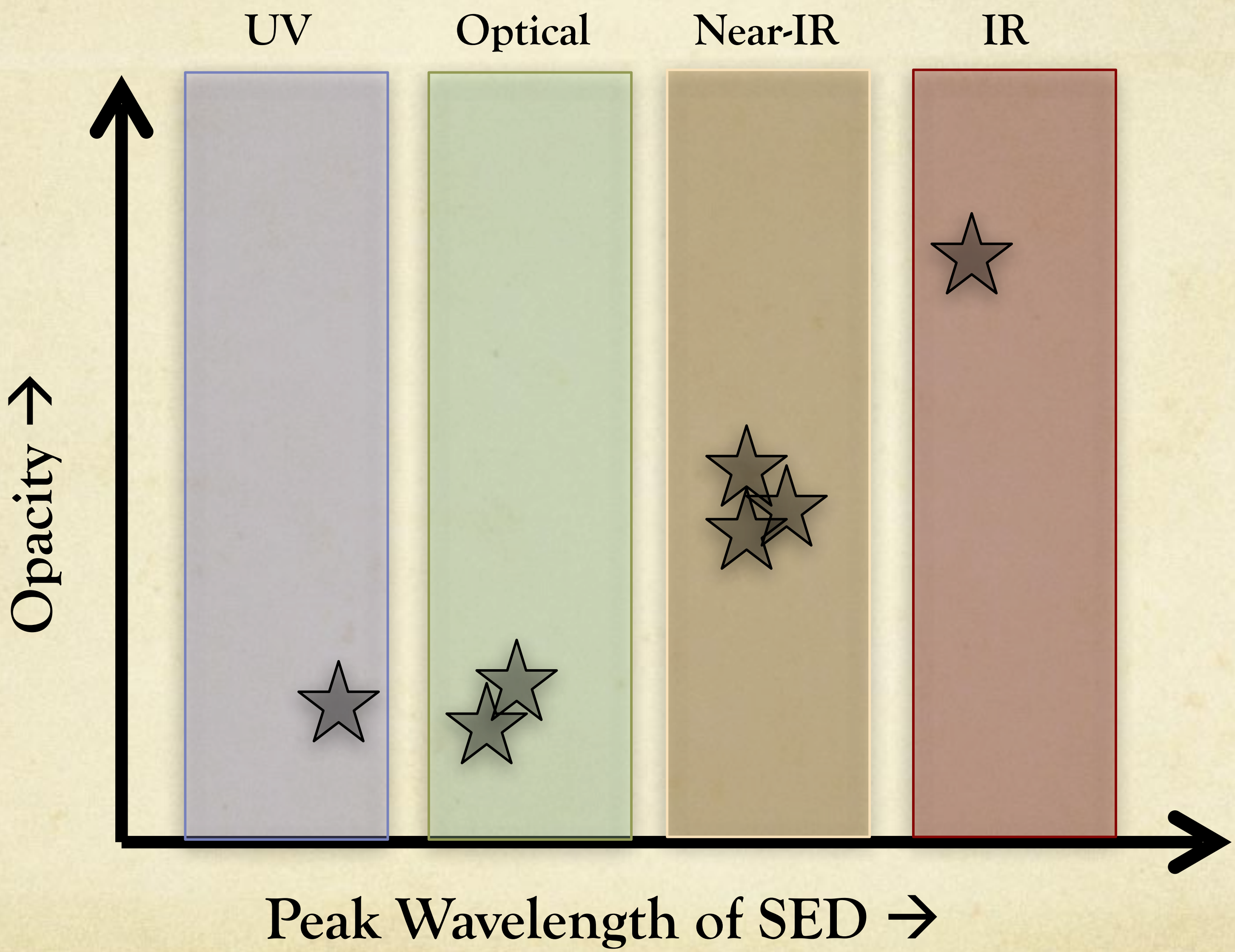
Maria R. Drout
Hubble, Carnegie-Dunlap Fellow

Image Credit: Robin Dienel/Carnegie Observatories

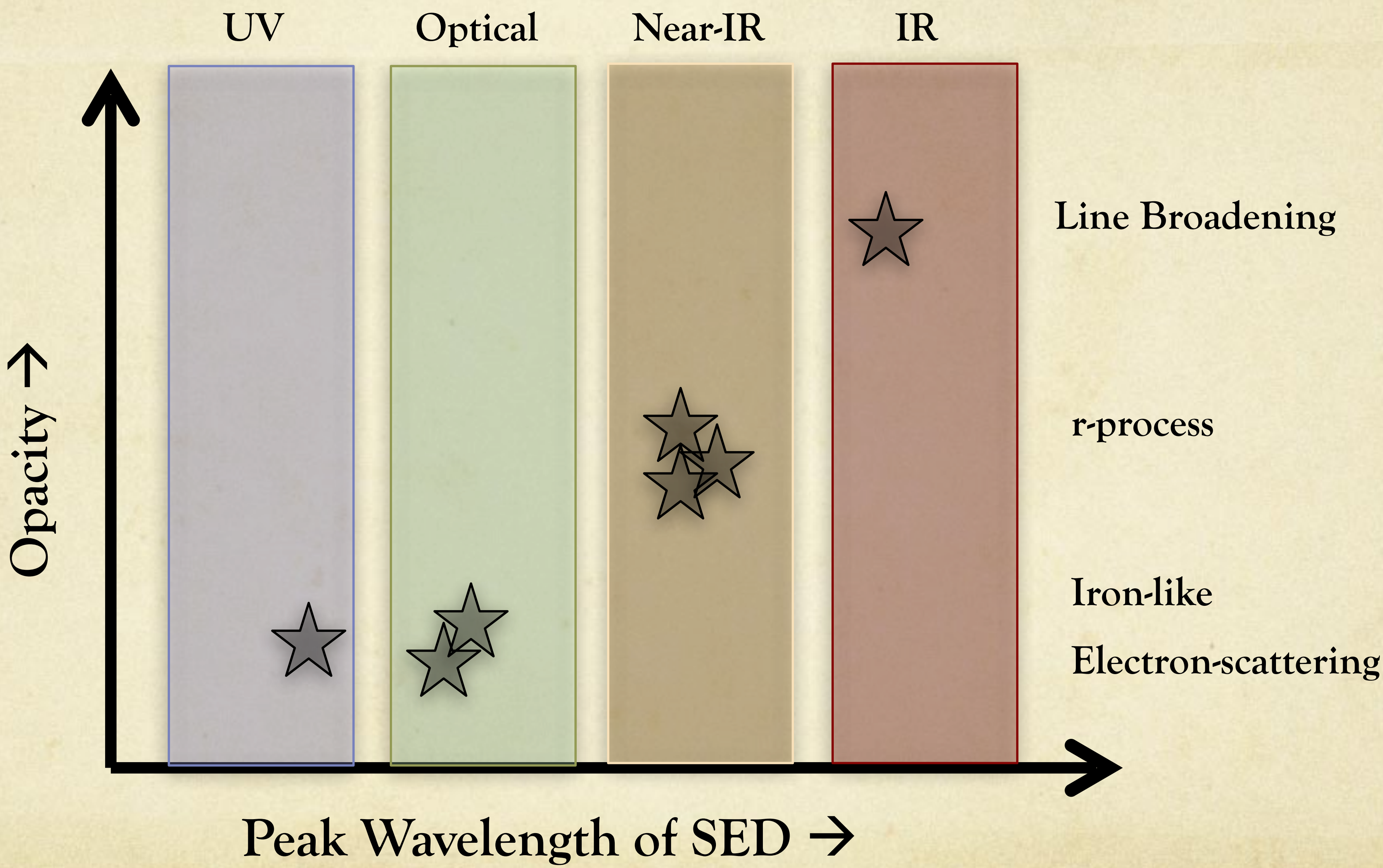
r-process nucleosynthesis



r-process transients

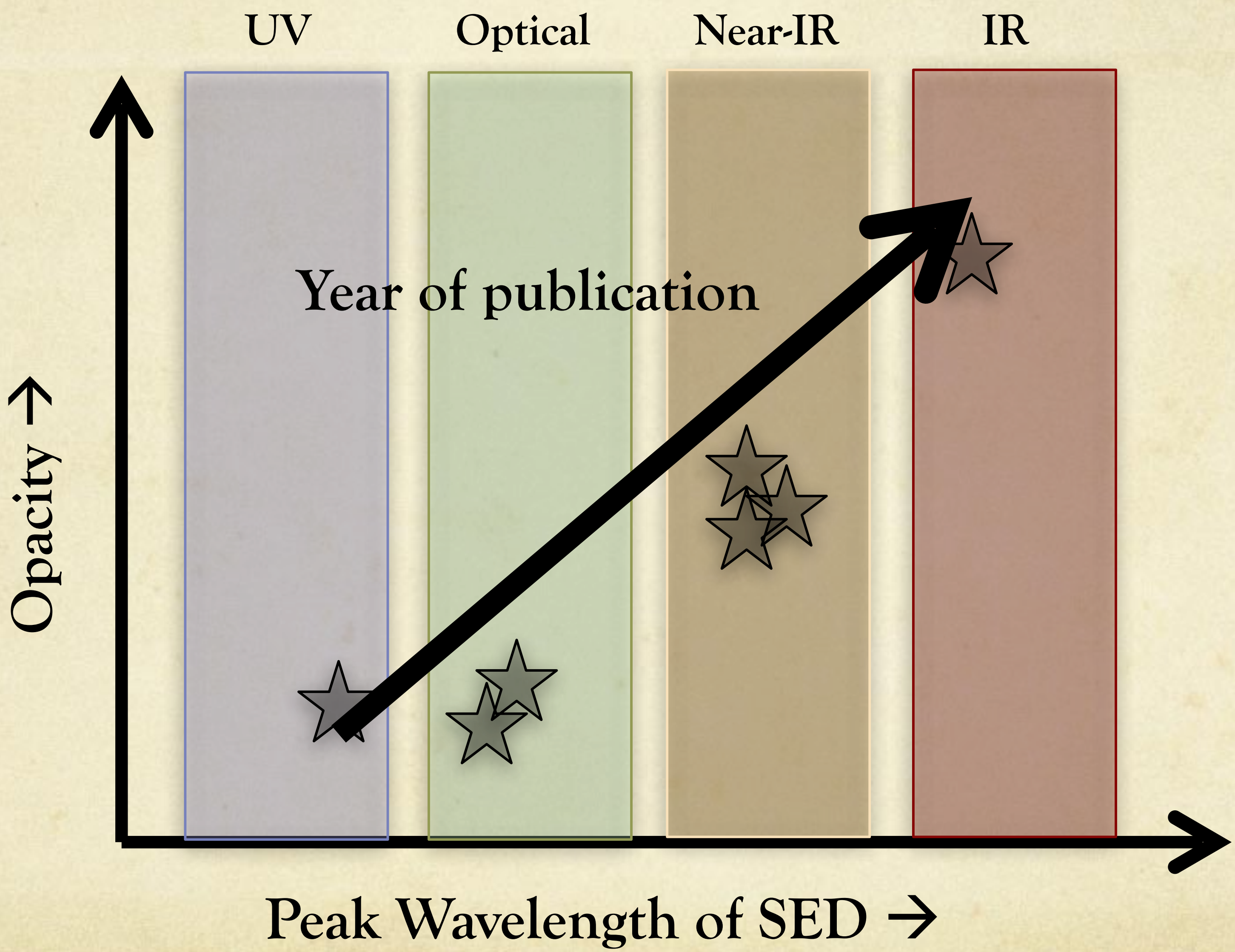


r-process transients



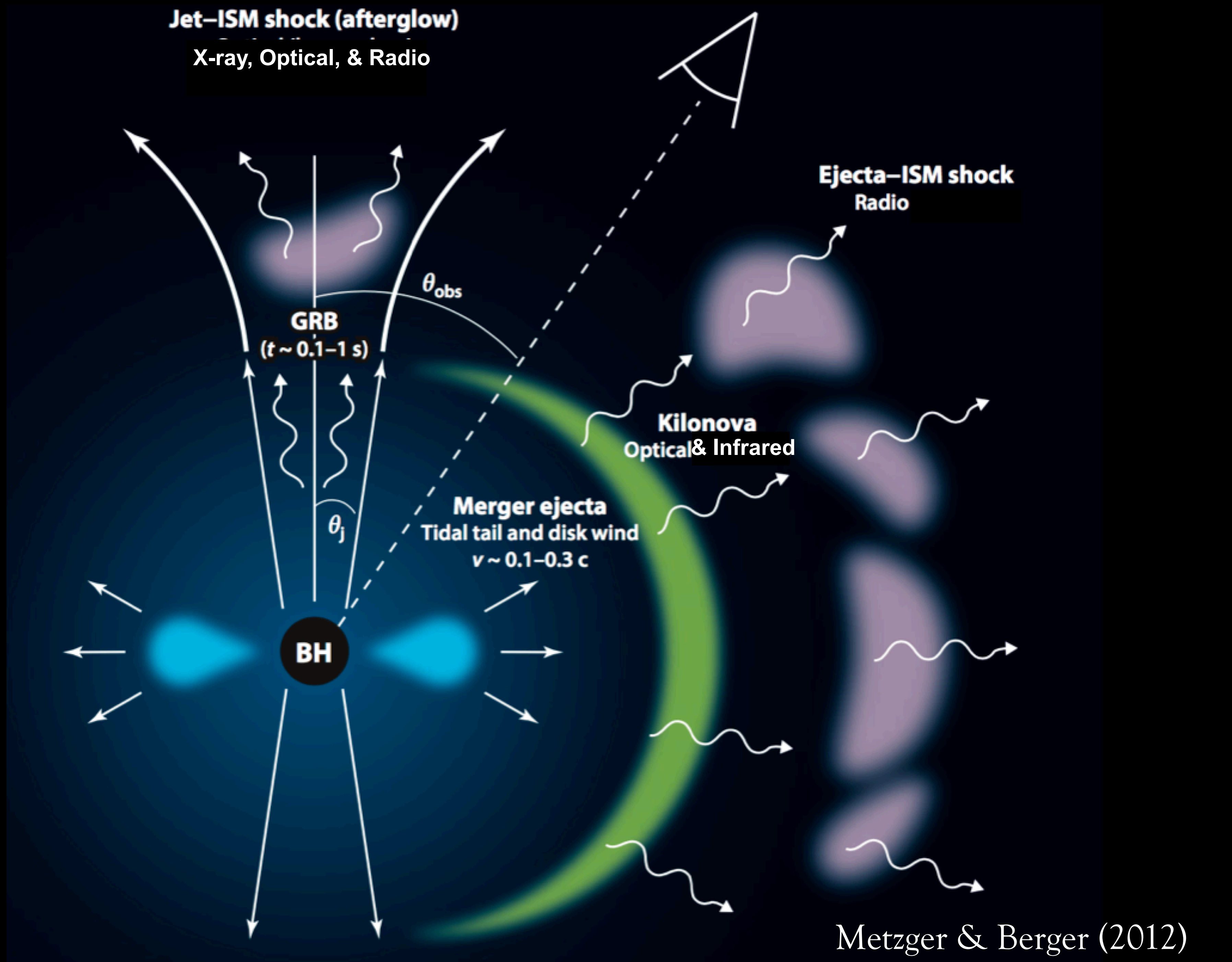
Li & Paczynski (1998), Metzger et al. (2010), Roberts et al. (2011), Barnes & Kasen (2013), Tanaka & Hotokezaka 2013; Metzer & Fernandez (2014), Martin et al. (2015), Tanaka et al. (2017)

r-process transients



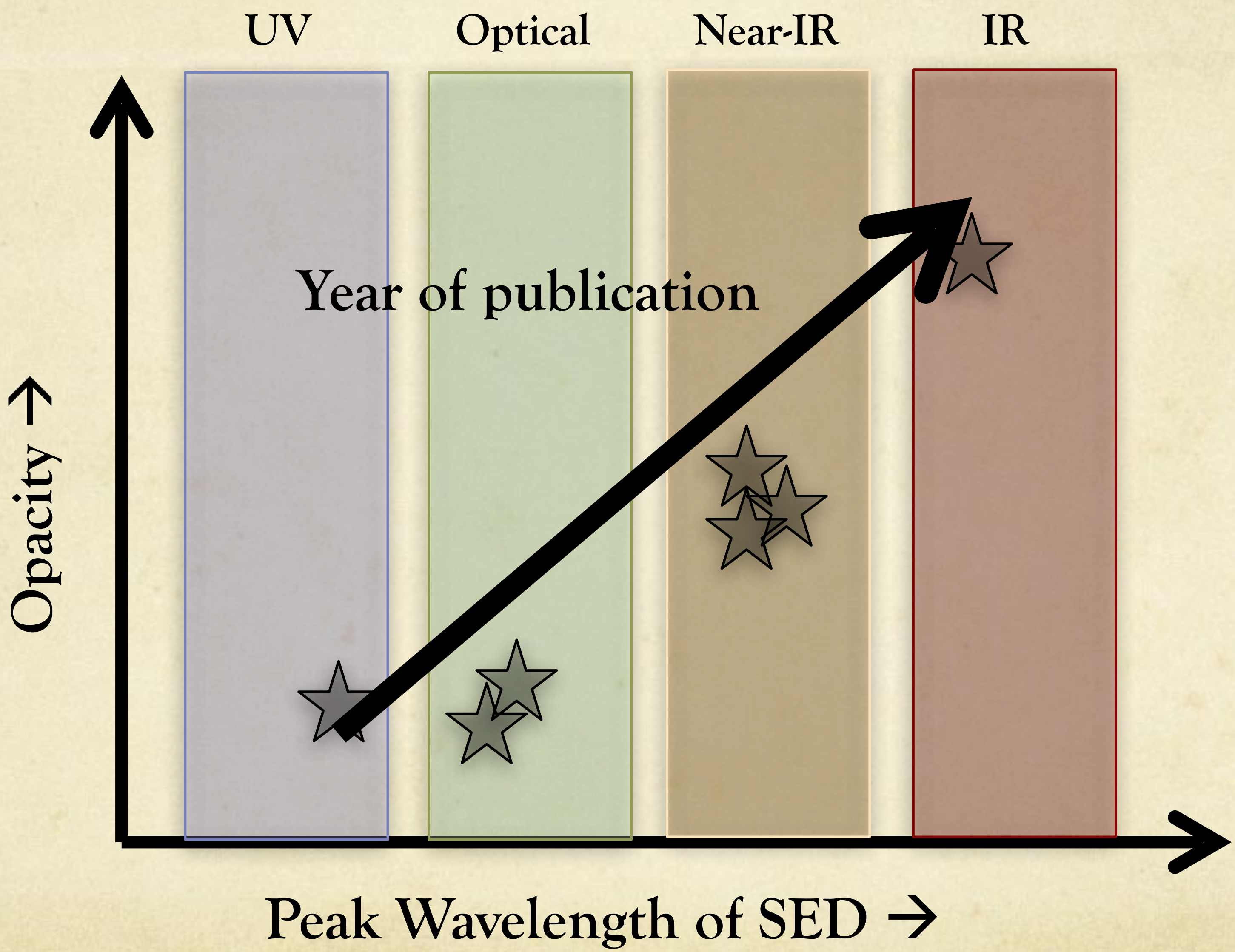
Li & Paczynski (1998), Metzger et al. (2010), Roberts et al. (2011), Barnes & Kasen (2013), Tanaka & Hotokezaka 2013; Metzer & Fernandez (2014), Martin et al. (2015), Tanaka et al. (2017)

EM Signals from Neutron-Star Mergers



Metzger & Berger (2012)

r-process transients



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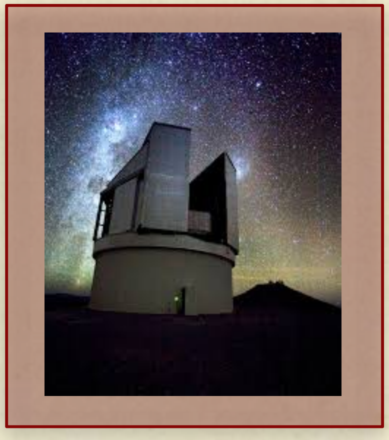
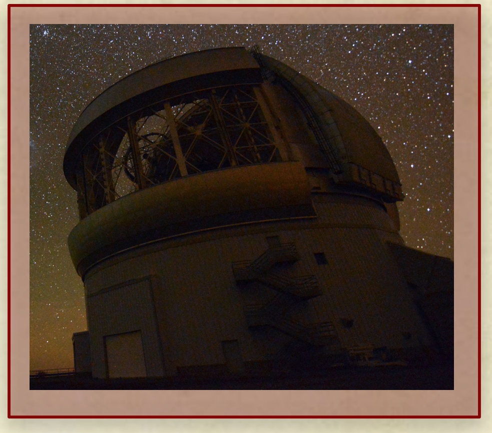
NIR Photometry (0.9 – 3 μm)

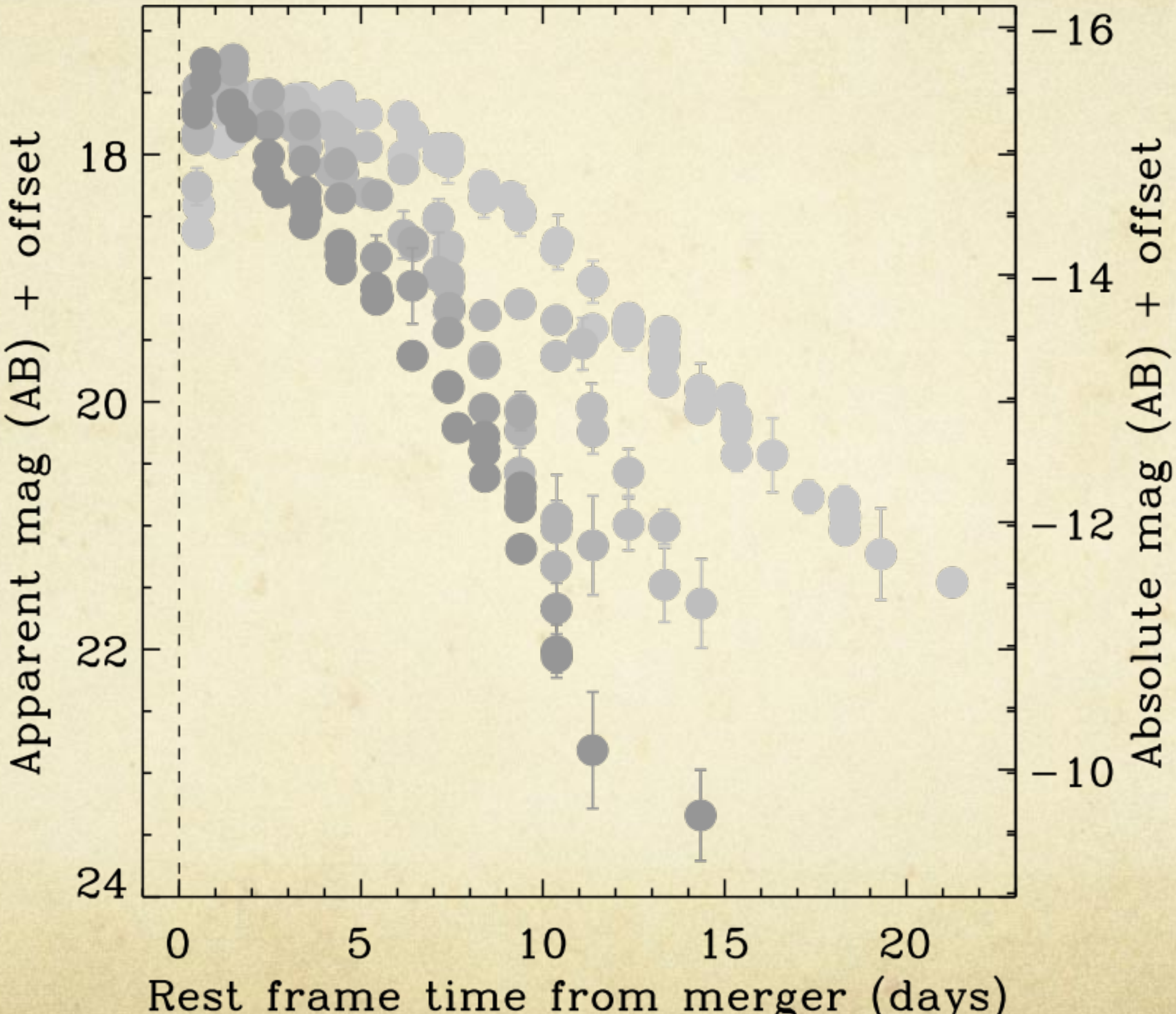




Cowperthwaite et al.; Drout et al.; Kasliwal et al.; Smartt et al.; Tanvir et al.
Troja et al.; Utsumi et al. ... et al...

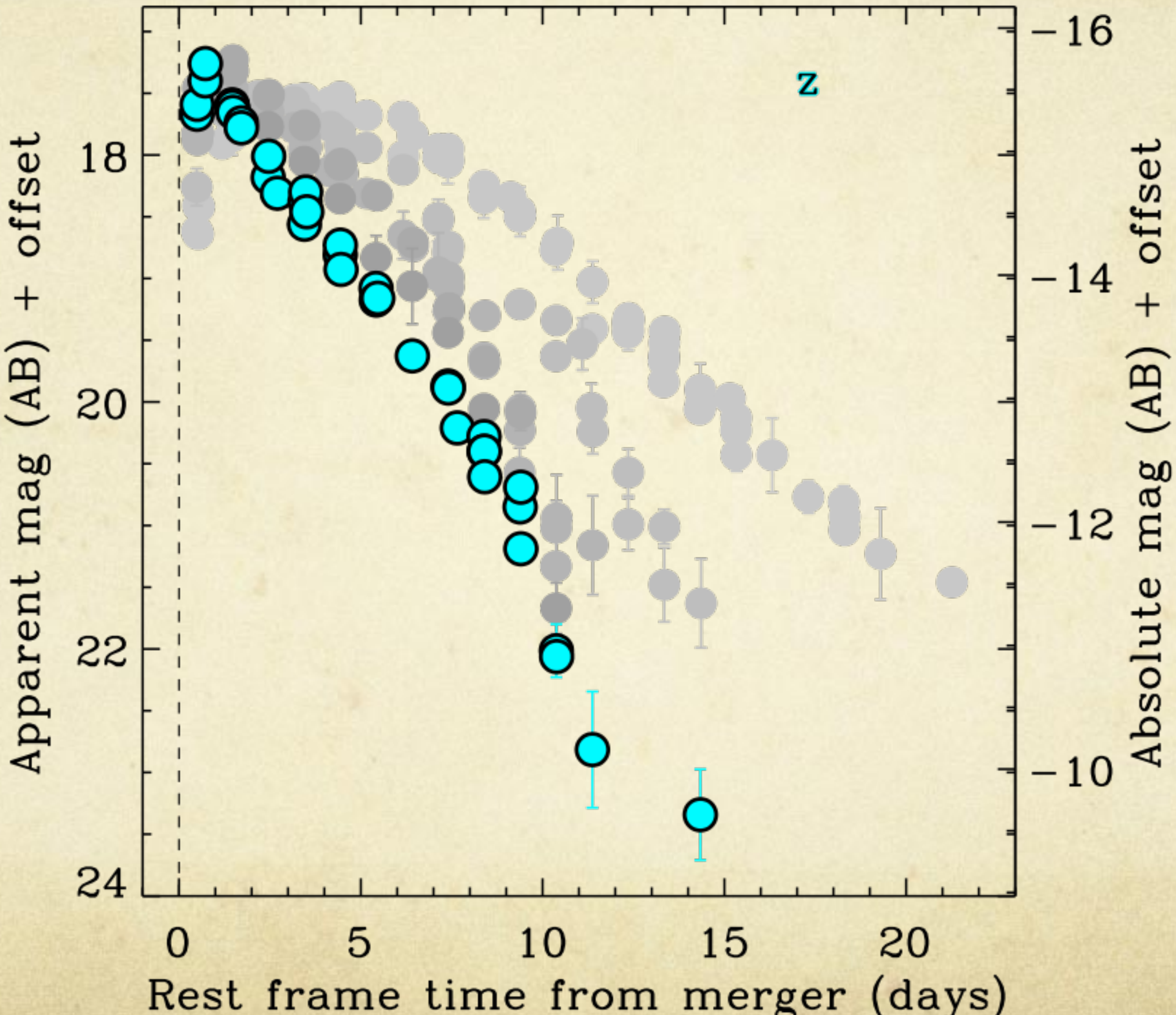
NIR Photometry

Light Curves



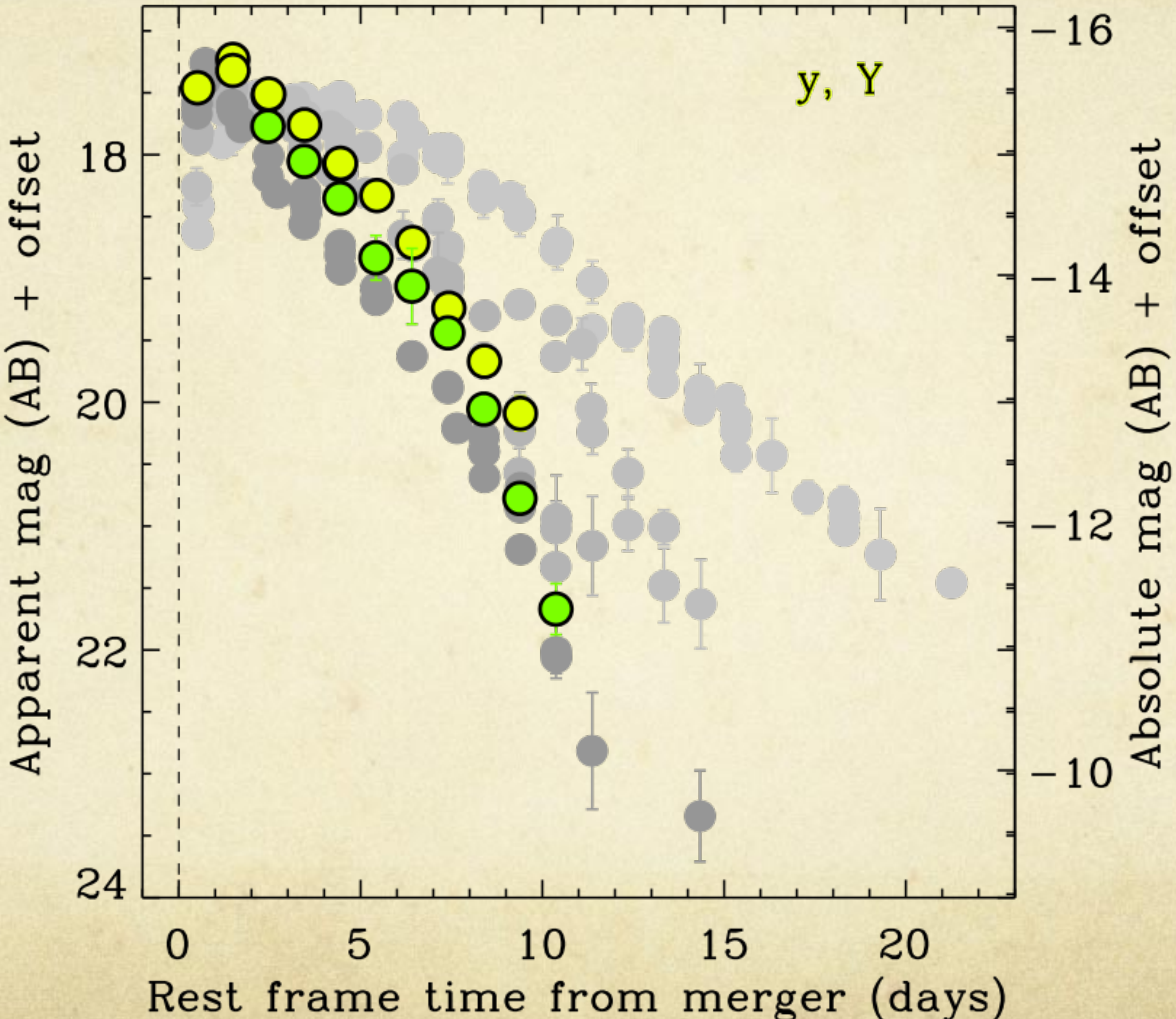
NIR Photometry

Light Curves



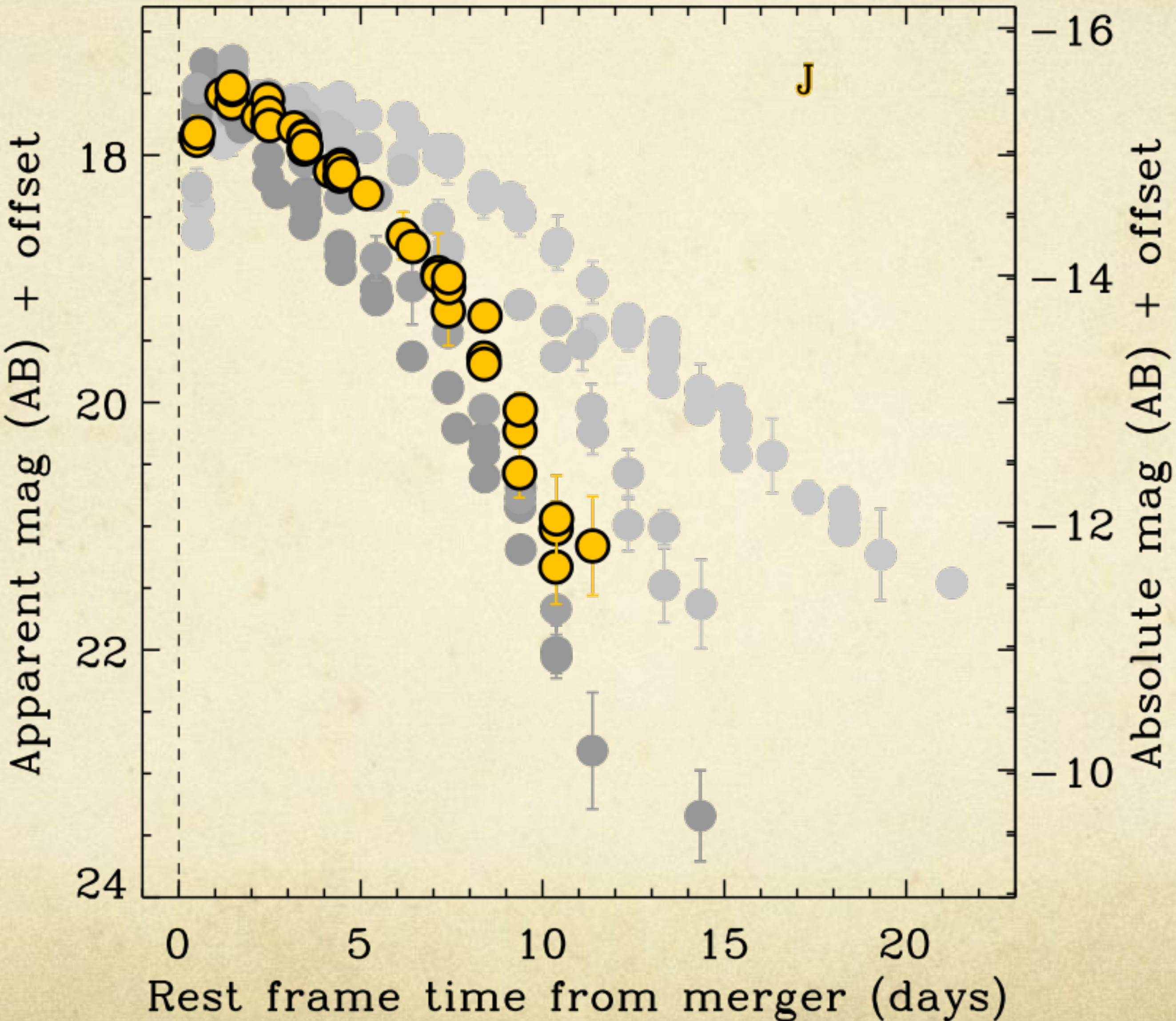
NIR Photometry

Light Curves



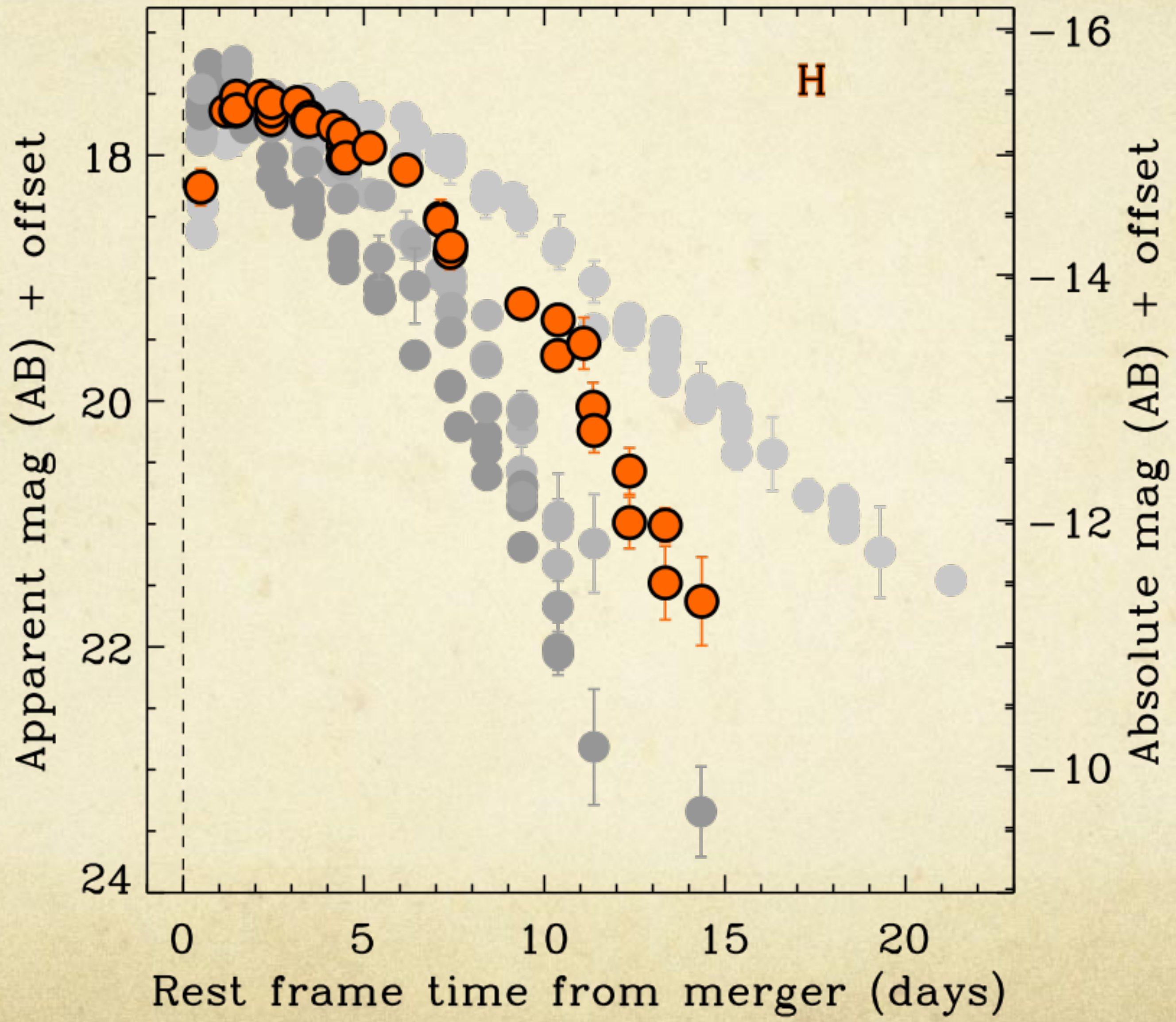
NIR Photometry

Light Curves



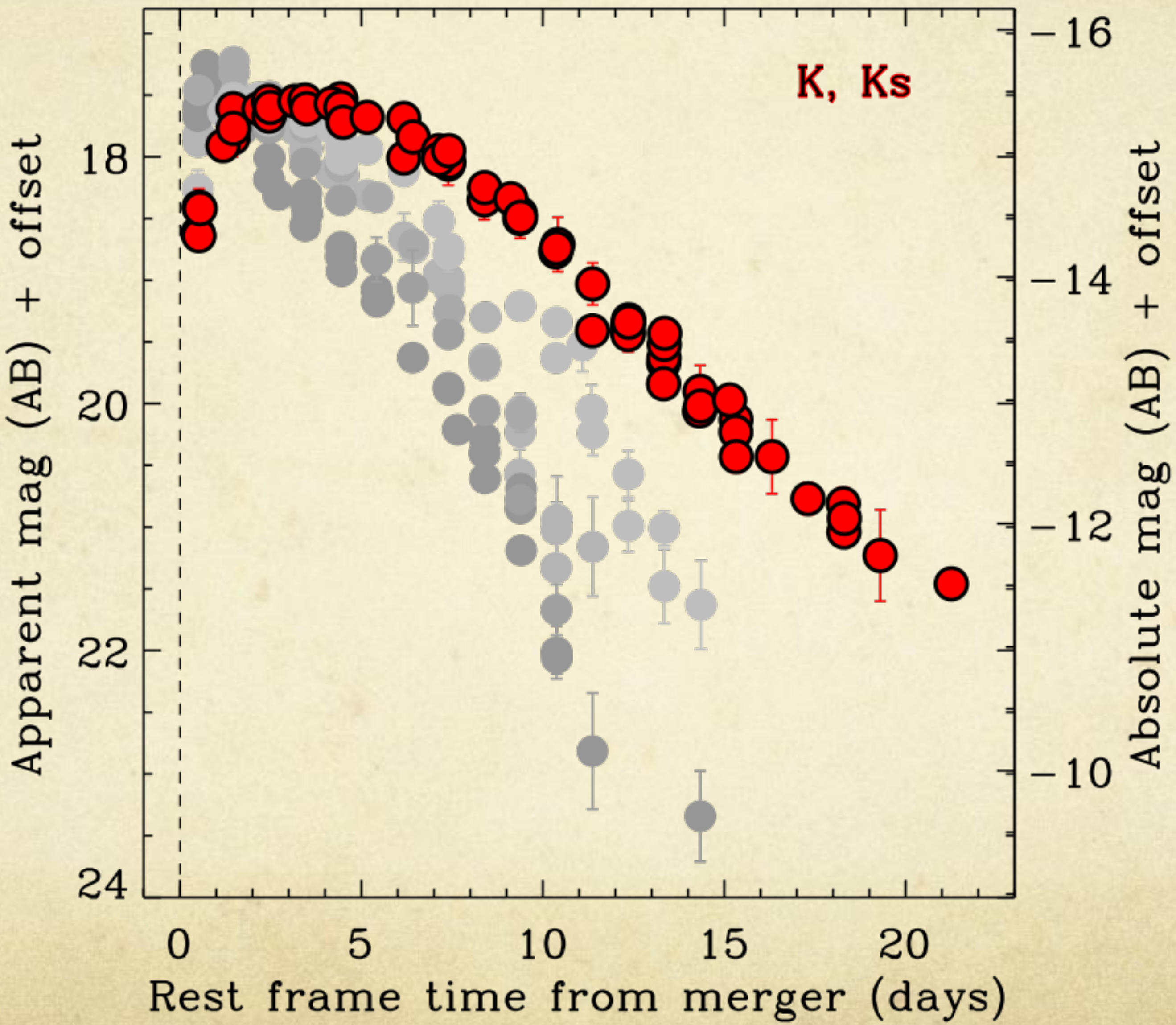
NIR Photometry

Light Curves



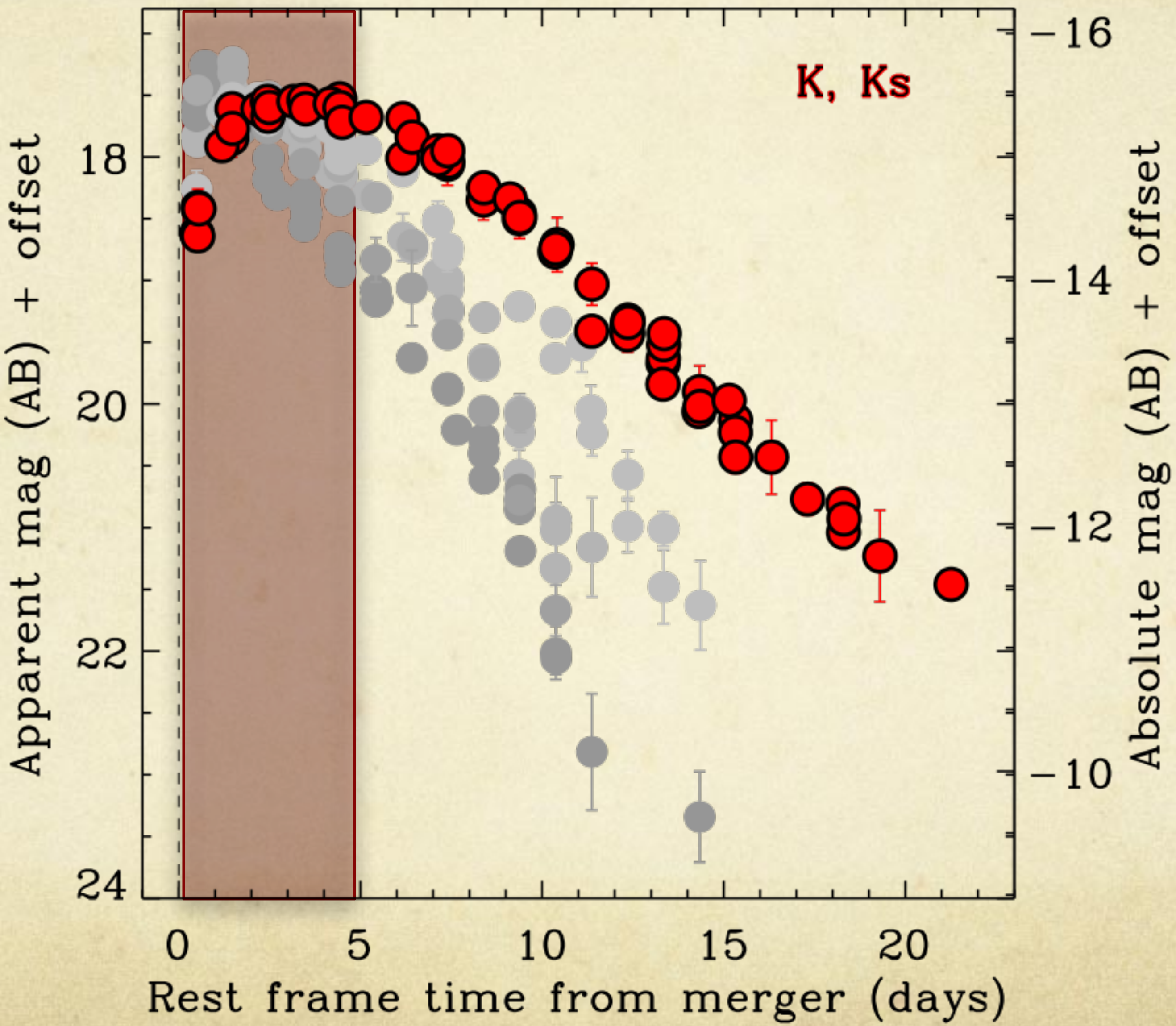
NIR Photometry

Light Curves



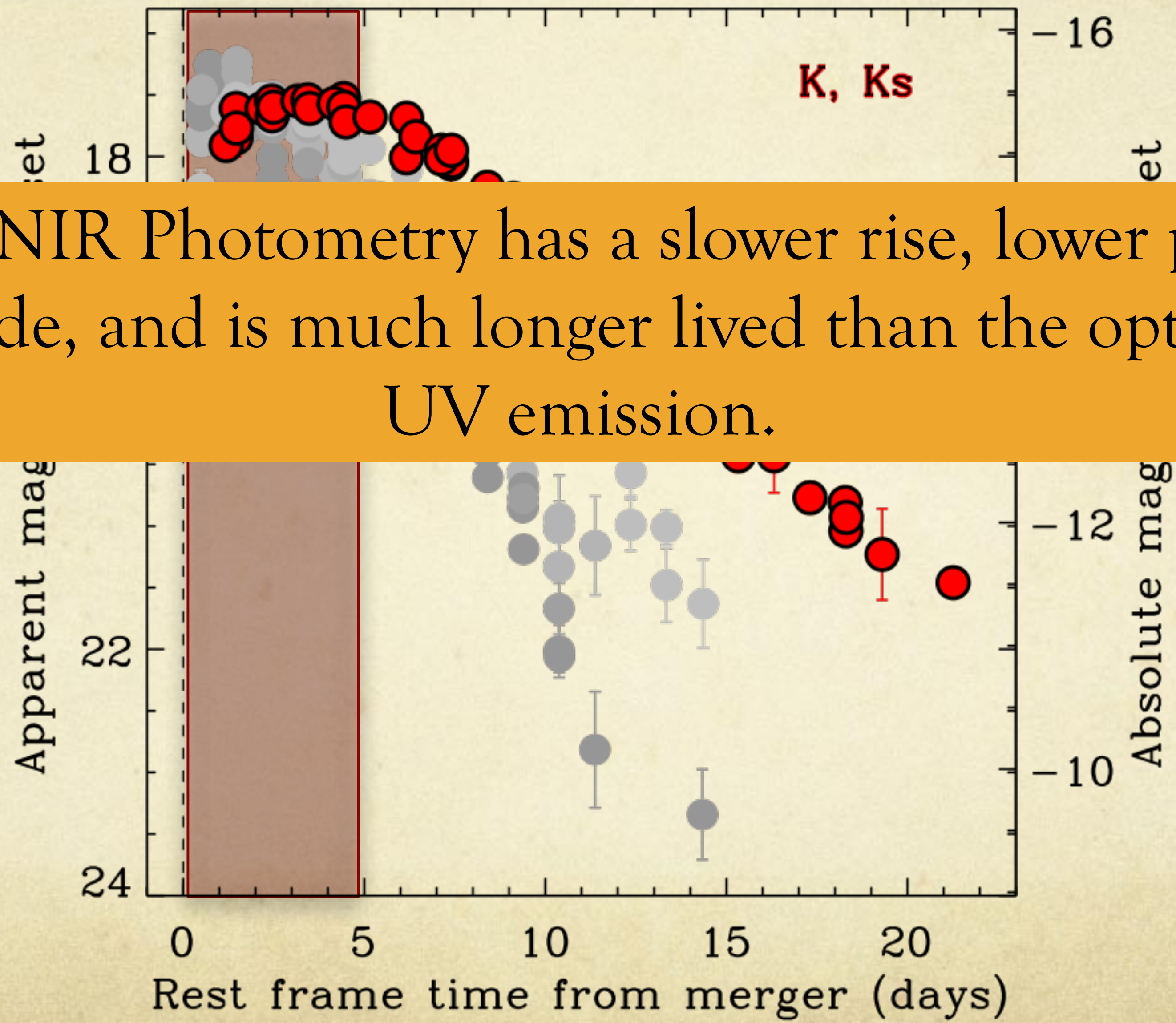
NIR Photometry

Light Curves



NIR Photometry

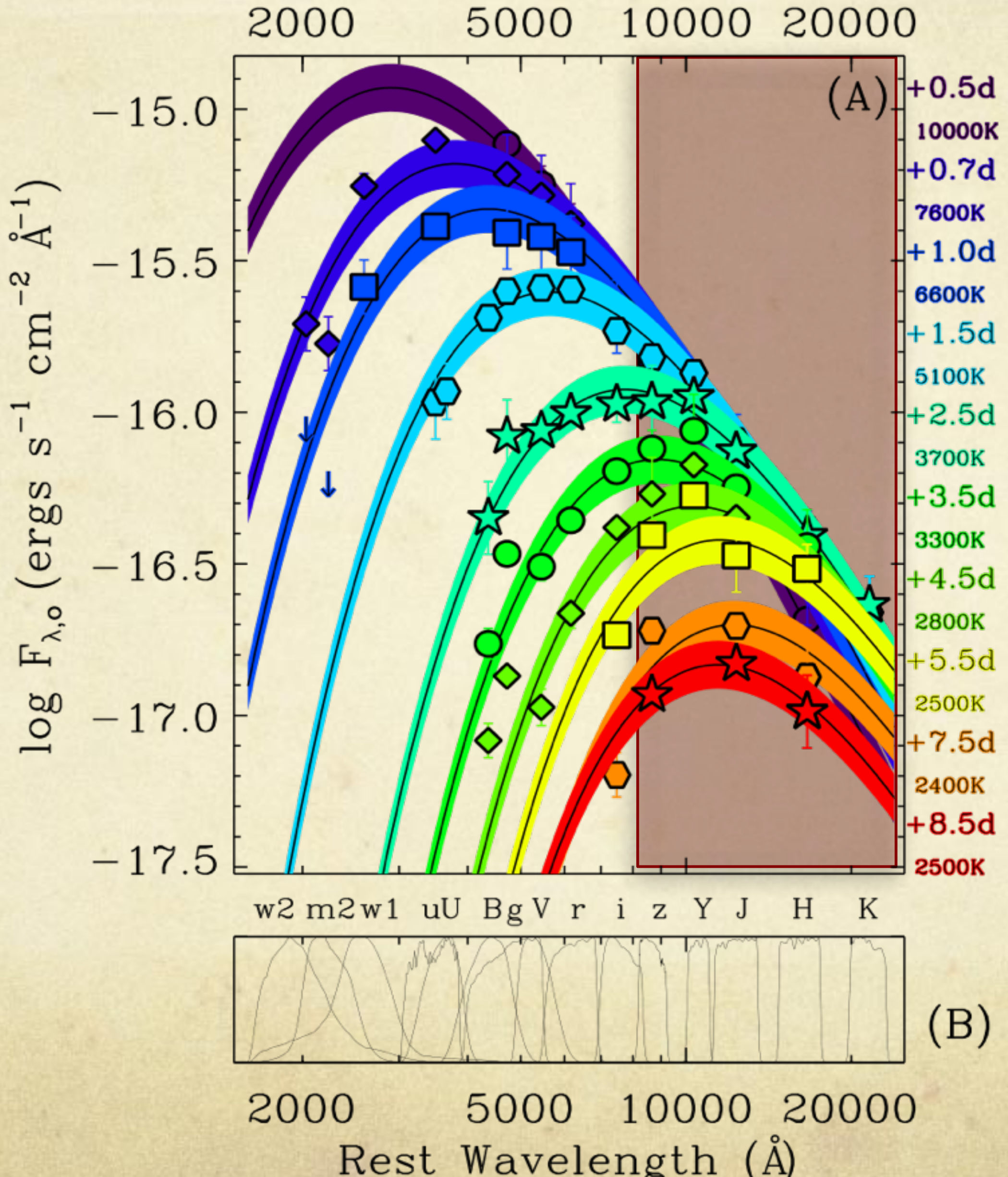
Light Curves



The NIR Photometry has a slower rise, lower peak magnitude, and is much longer lived than the optical and UV emission.

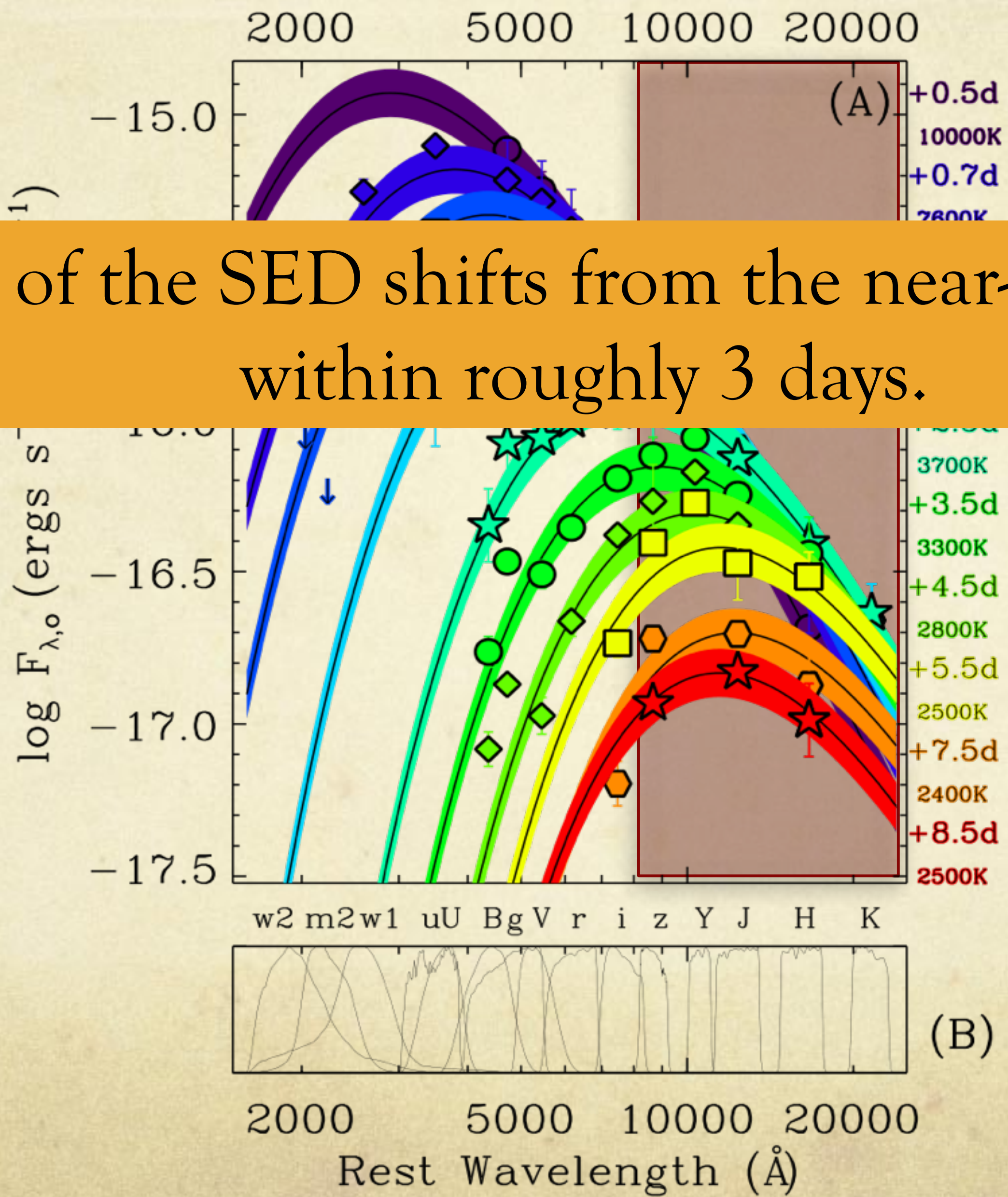
NIR Photometry

Spectral Energy Distribution



NIR Photometry

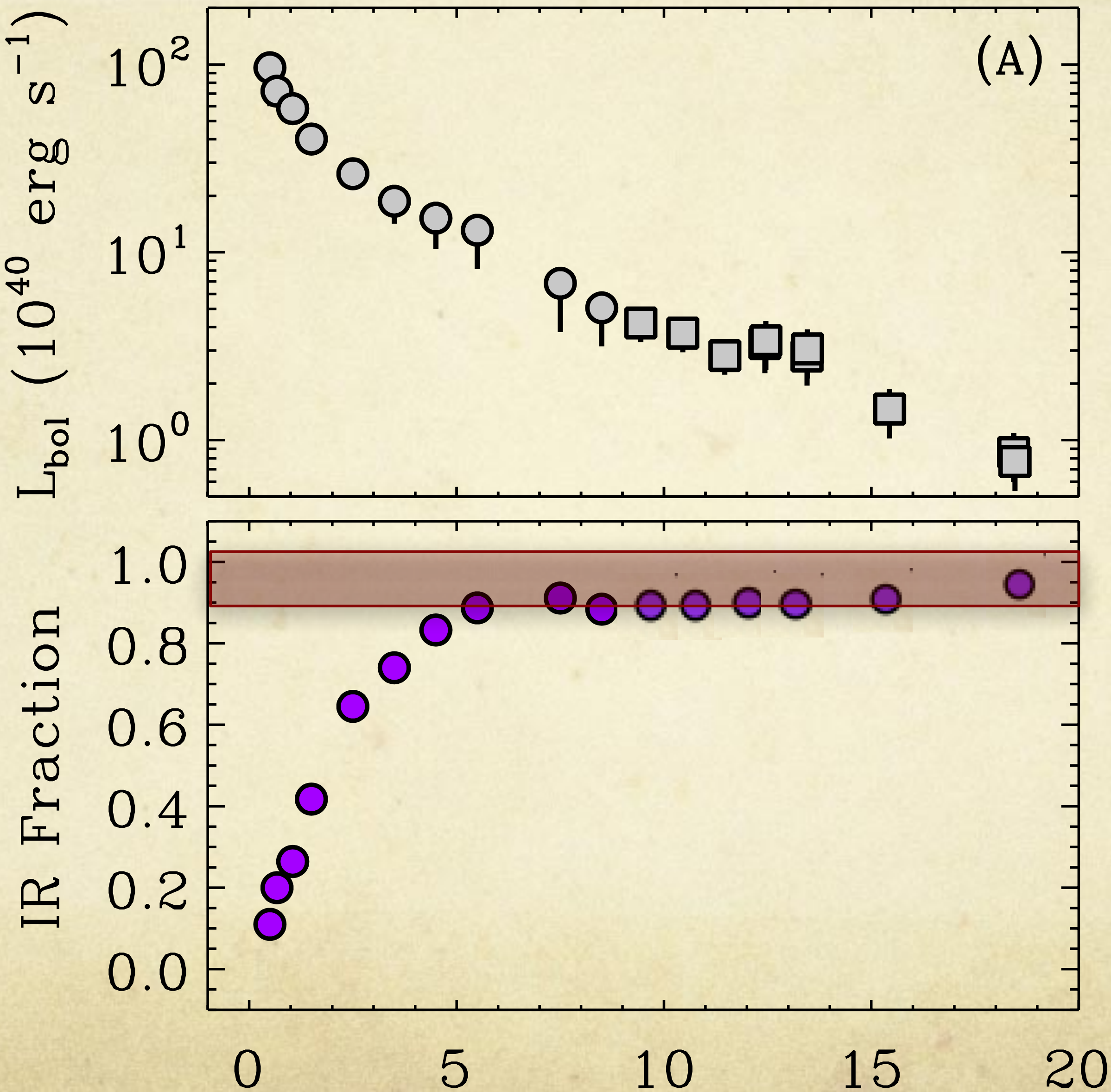
Spectral Energy Distribution



The Peak of the SED shifts from the near-UV to near-IR within roughly 3 days.

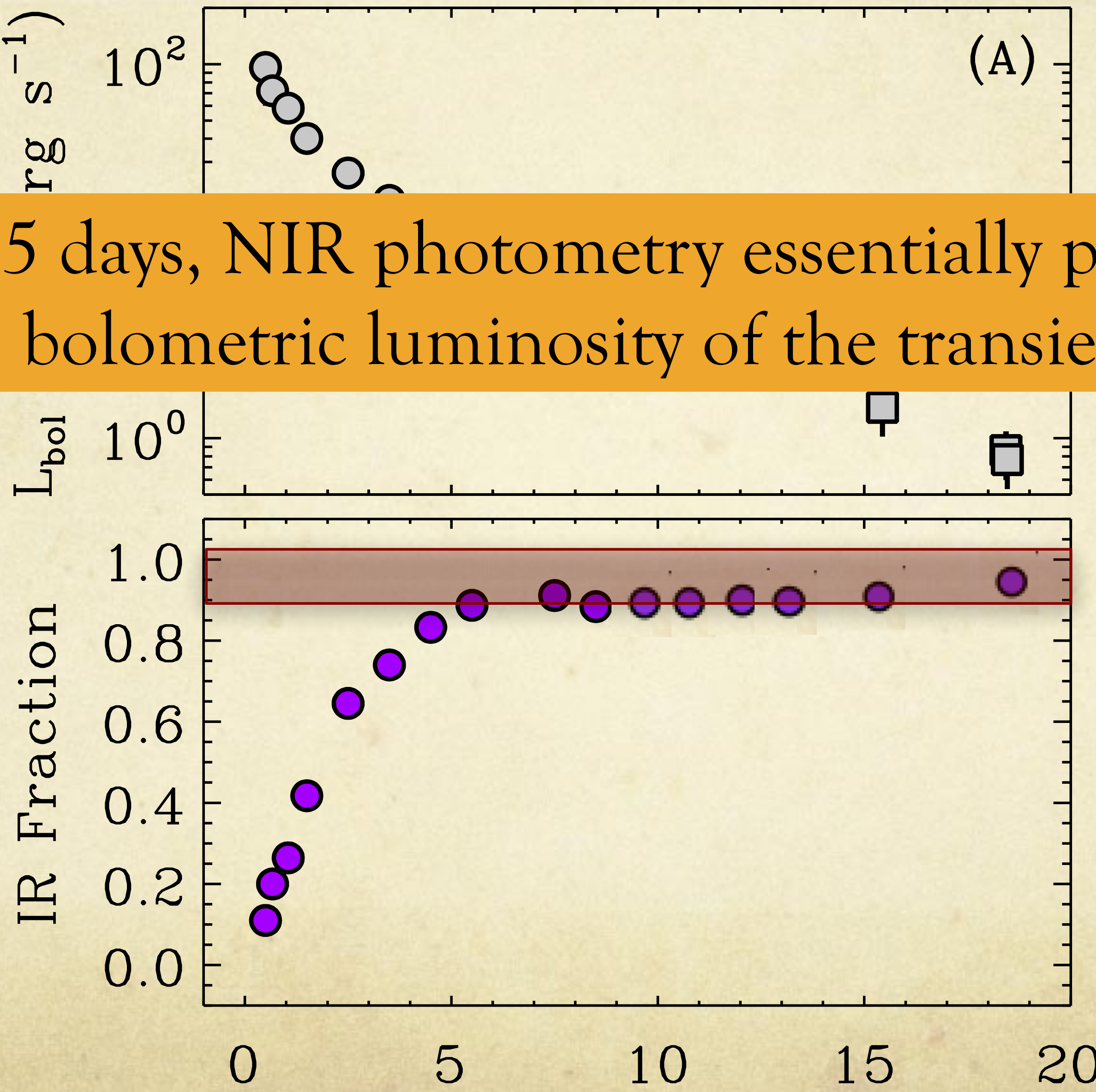
NIR Photometry

Contributions to Bolometric Luminosity



NIR Photometry

Contributions to Bolometric Luminosity



After 5 days, NIR photometry essentially probes the bolometric luminosity of the transient.

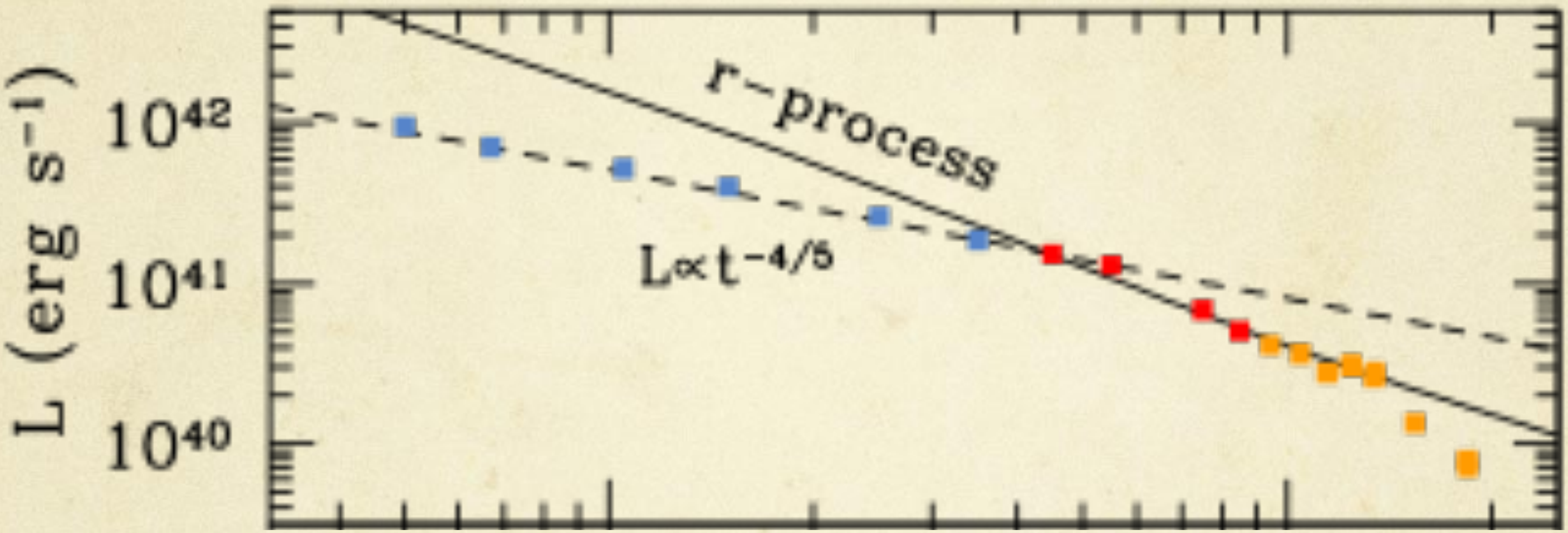
NIR Photometry

NIR Photometry

Evidence for a (lanthanide-rich) r-process transient

NIR Photometry

Evidence for a (lanthanide-rich) r-process transient

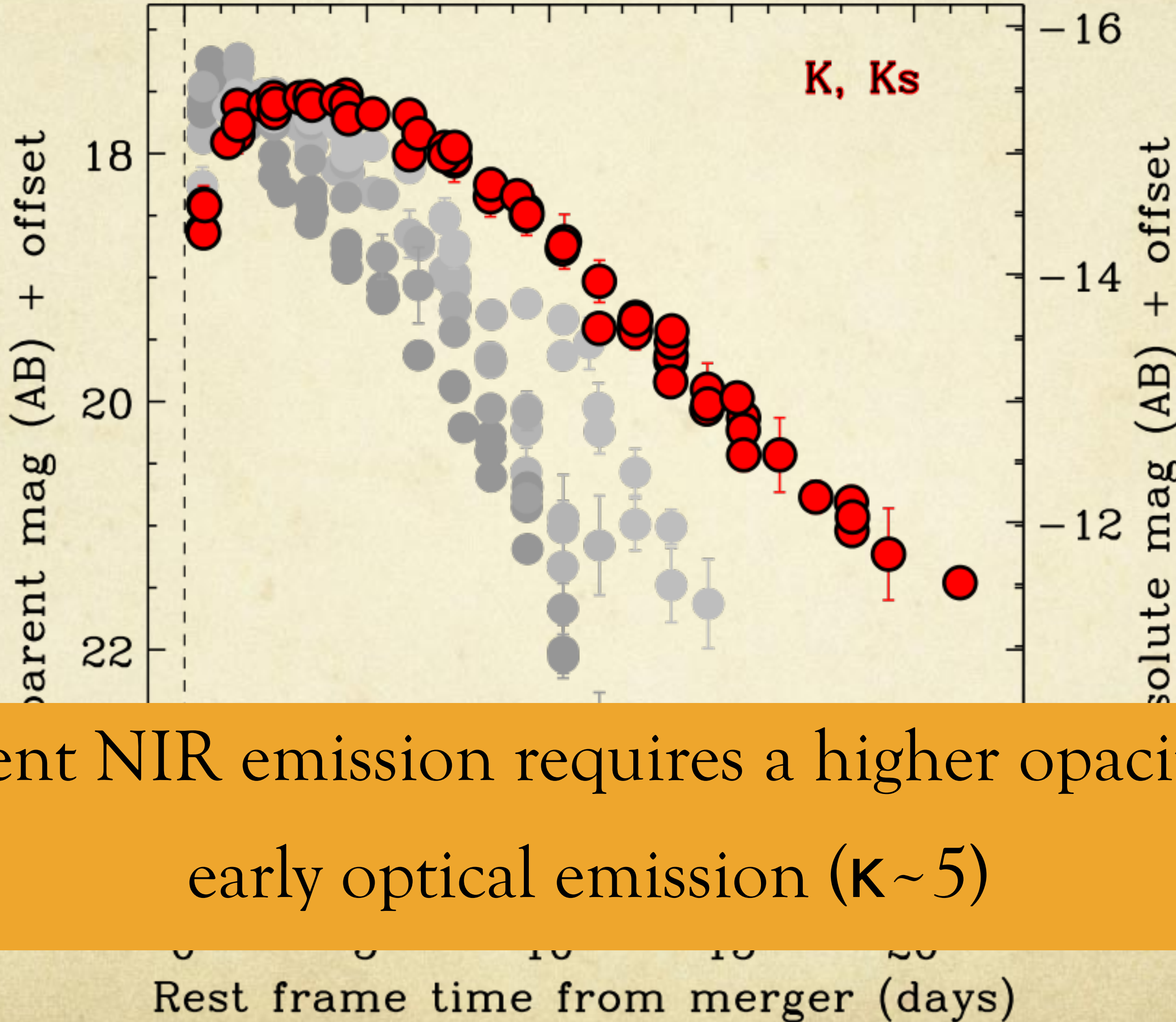


Luminosity between 3 and 18 days is consistent with a $t^{-1.3}$ power law

Piro & Kollmeier (2017)

NIR Photometry

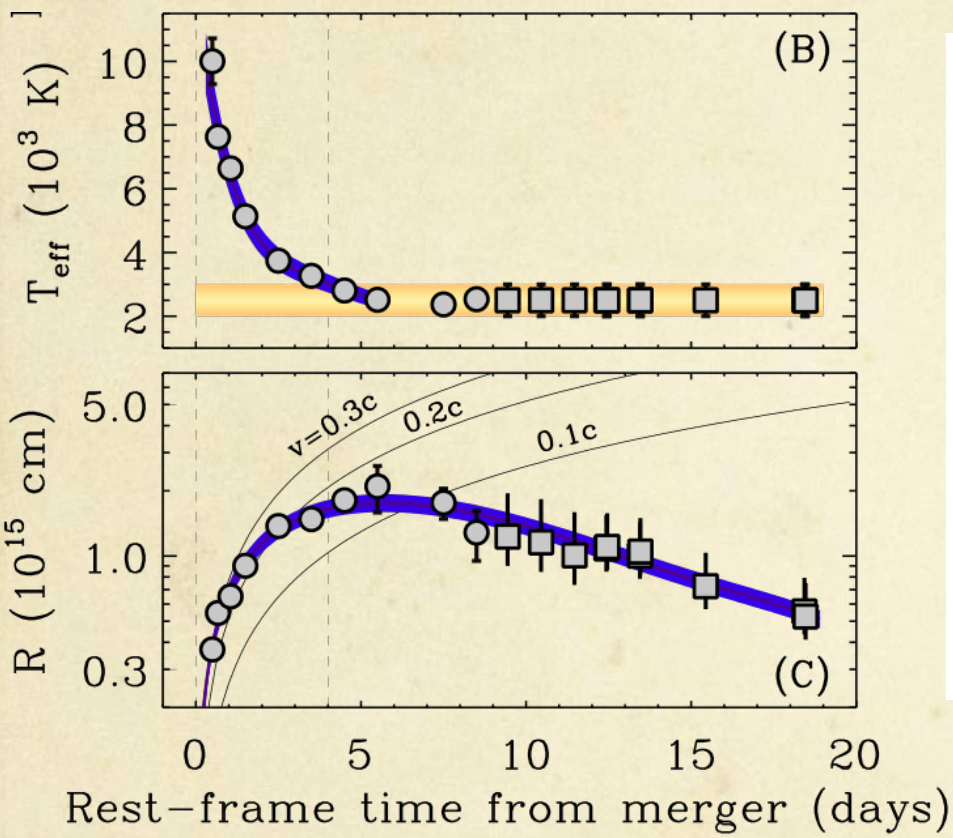
Evidence for a (lanthanide-rich) r-process transient

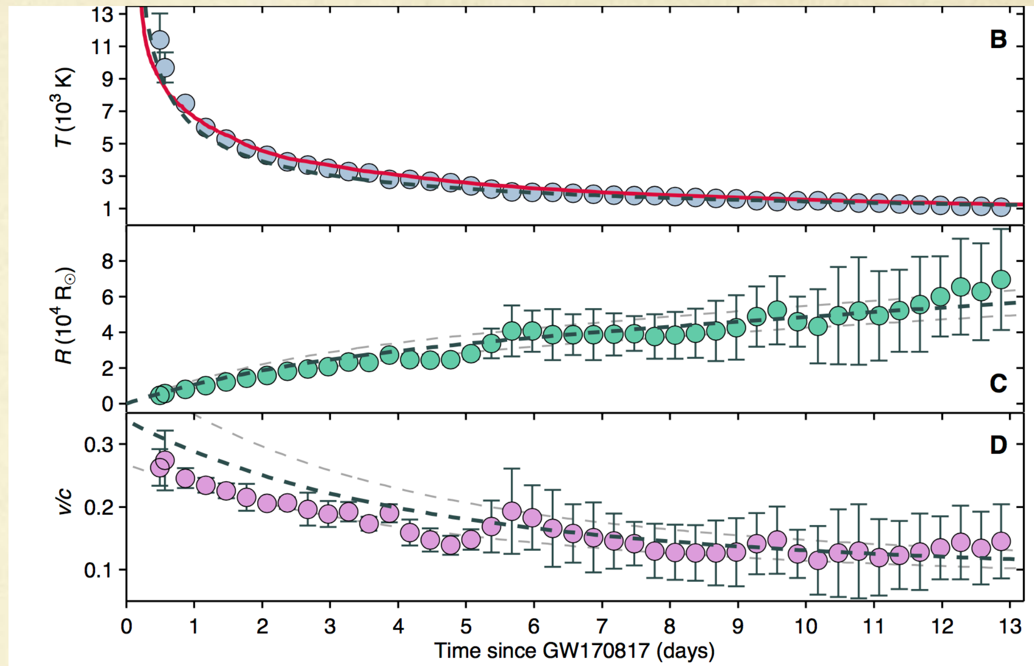


Persistent NIR emission requires a higher opacity than early optical emission (κ~5)

NIR Photometry

Evidence for a (lanthanide-rich) r-process transient





Temperature and photospheric radius evolution consistent with lanthanide recombination

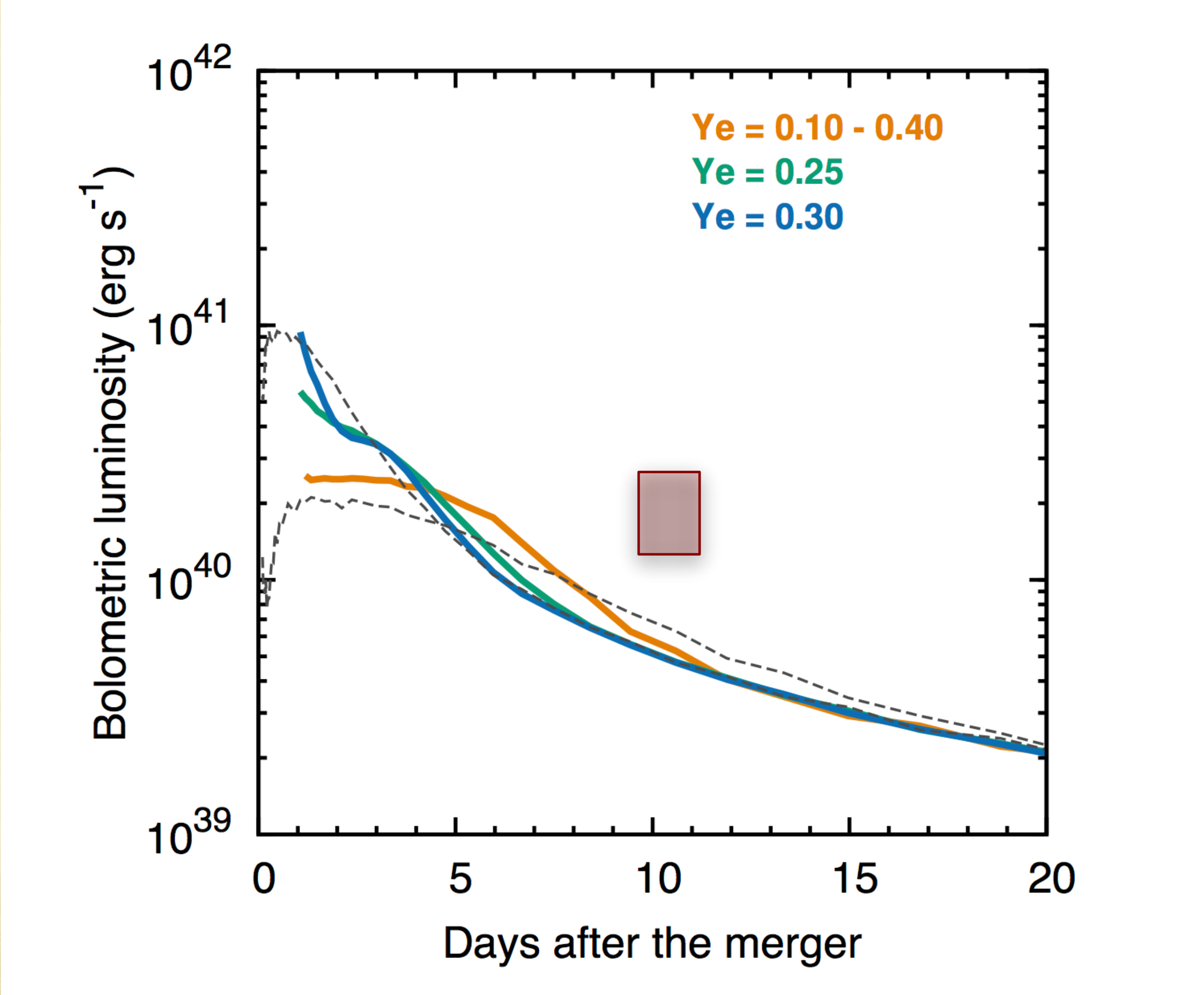
Drout et al (2017); Kasliwal et al. (2017)

NIR Photometry

Evidence for a (lanthanide-rich) r-process transient

NIR Photometry

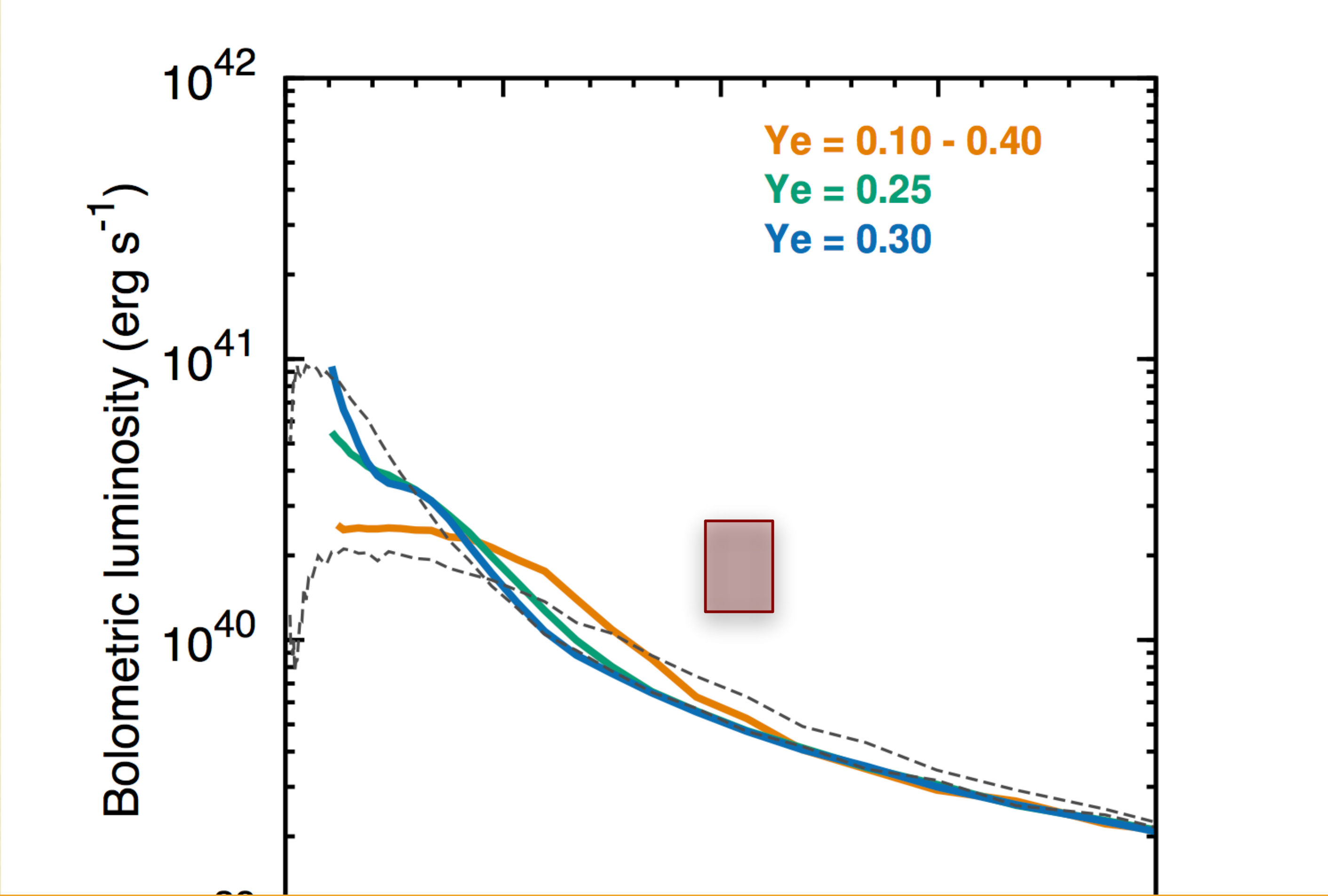
Evidence for a (lanthanide-rich) r-process transient



Tanaka et al. (2017)

NIR Photometry

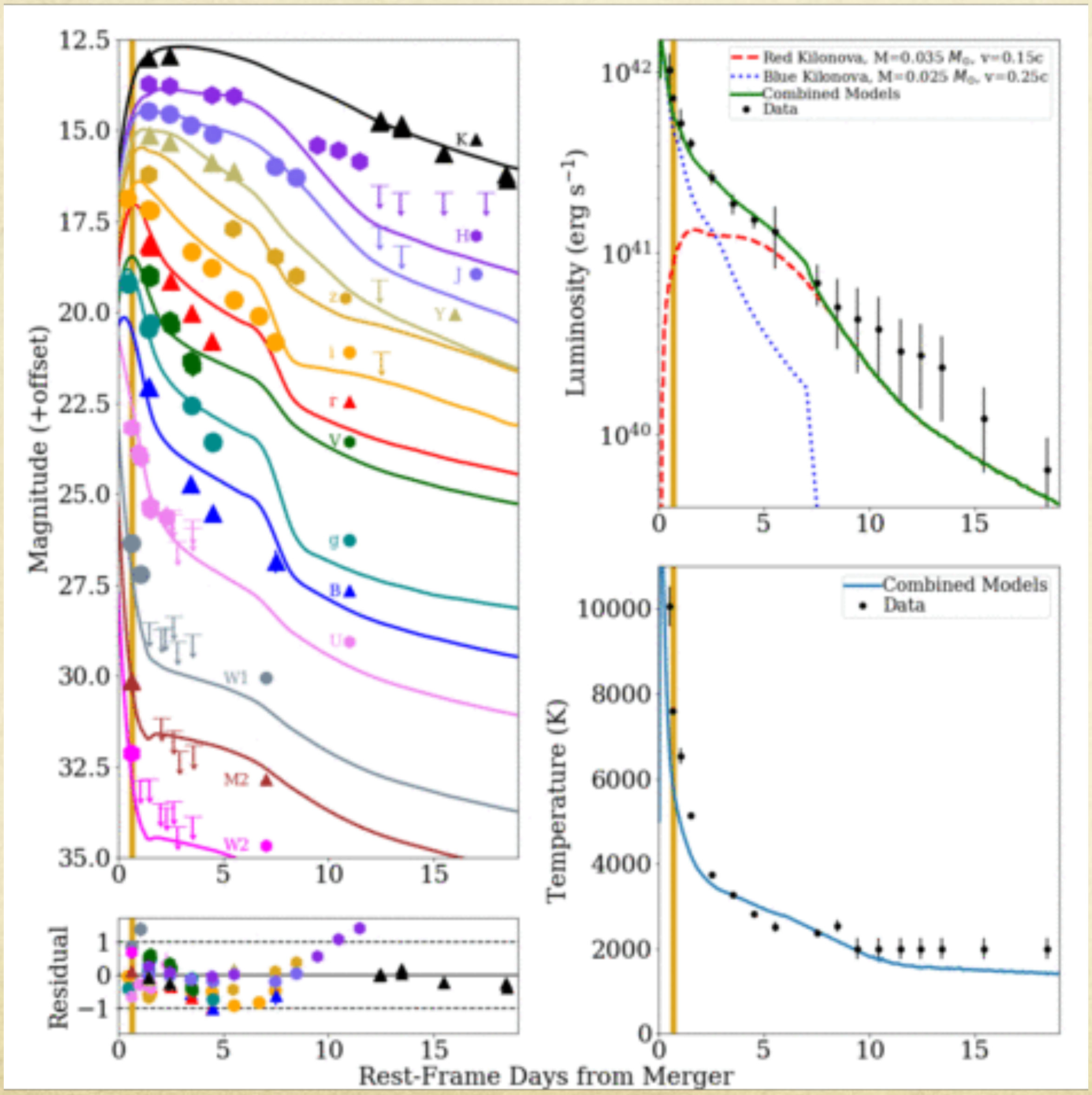
Evidence for a (lanthanide-rich) r-process transient



What about mass of material, velocity, and therefore origin of the lanthanide-rich component in GW170817?

NIR Photometry

Ejecta Mass and Velocity

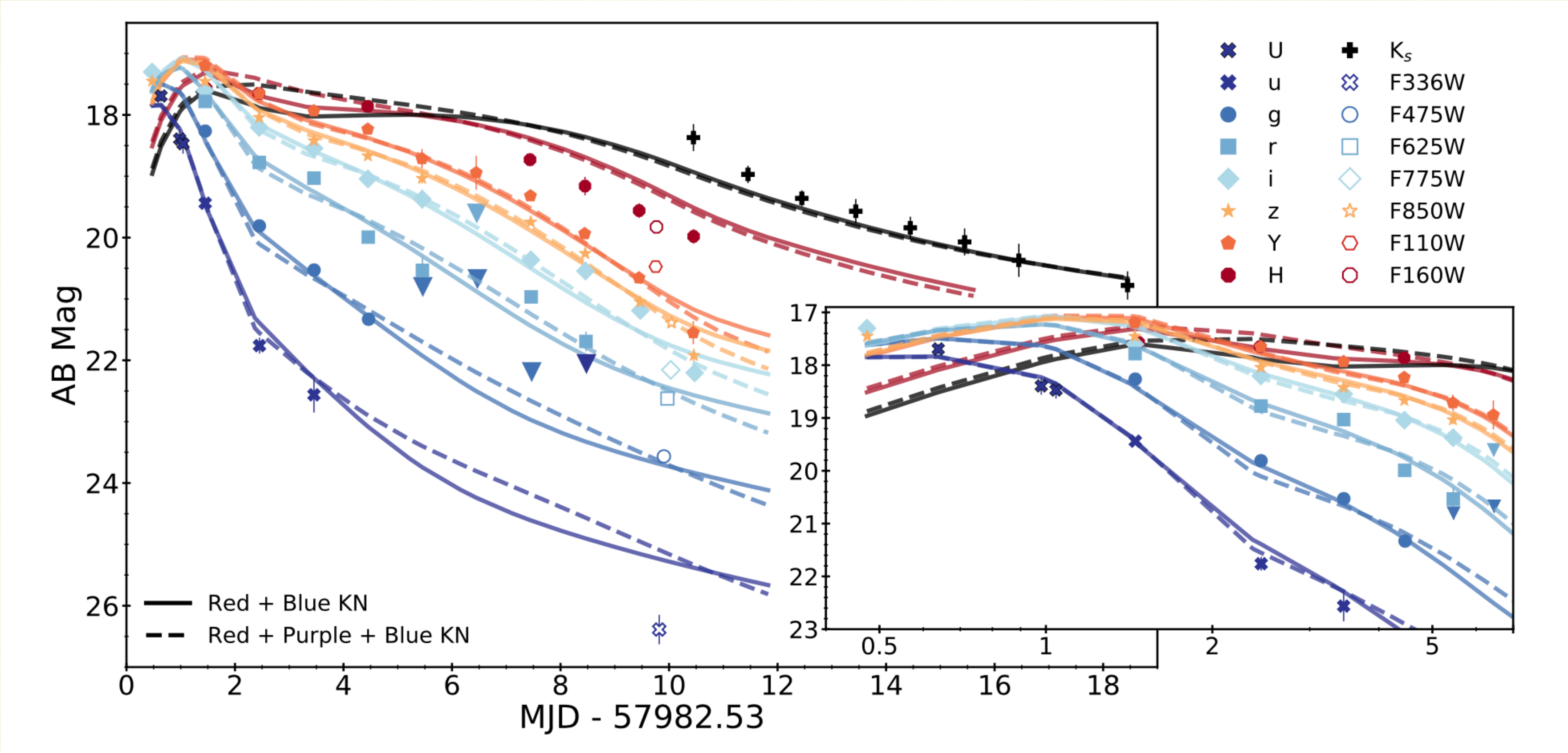


M = 0.035 Msun
v = 0.15c

Kilpatrick et al. (2017), Kasen et al. (2017)

NIR Photometry

Ejecta Mass and Velocity

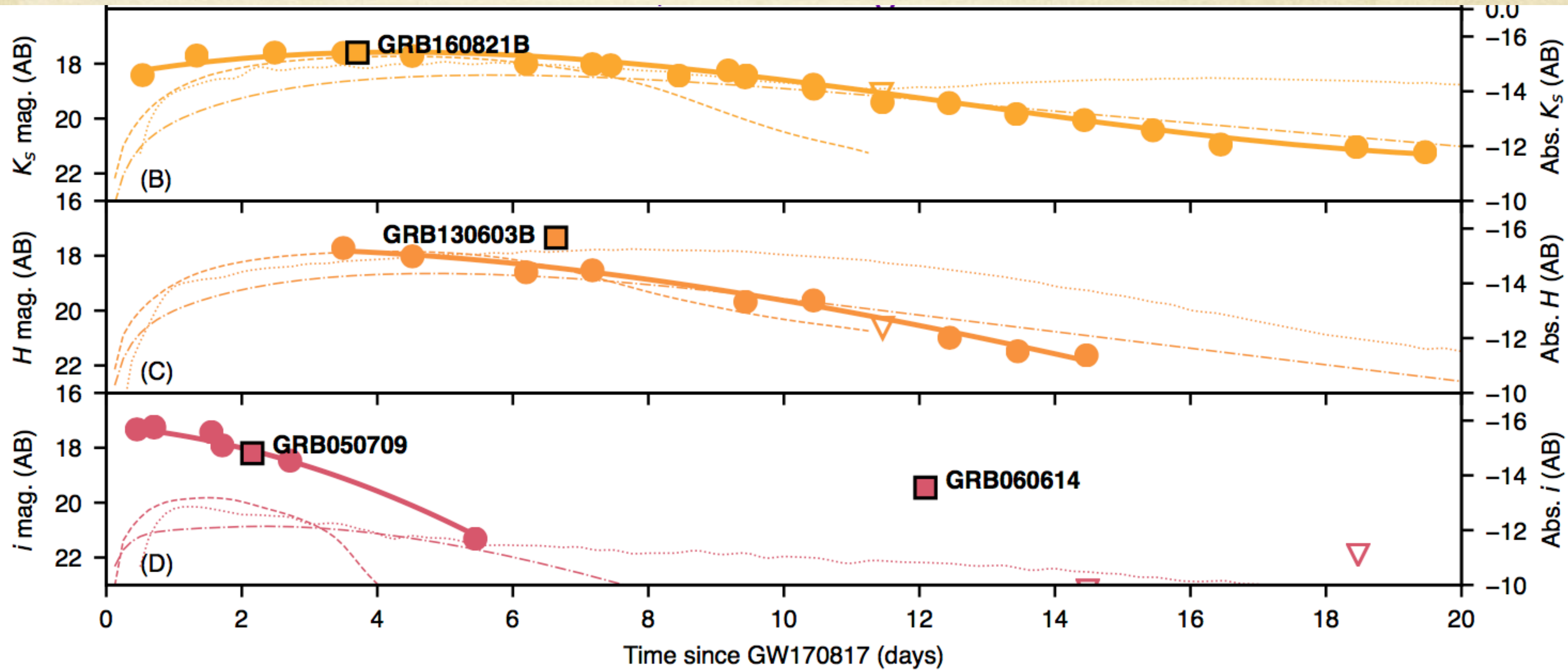


M = 0.04 Msun; v = 0.12c

Cowperthwaite et al (2017); Villar et al (2017)

NIR Photometry

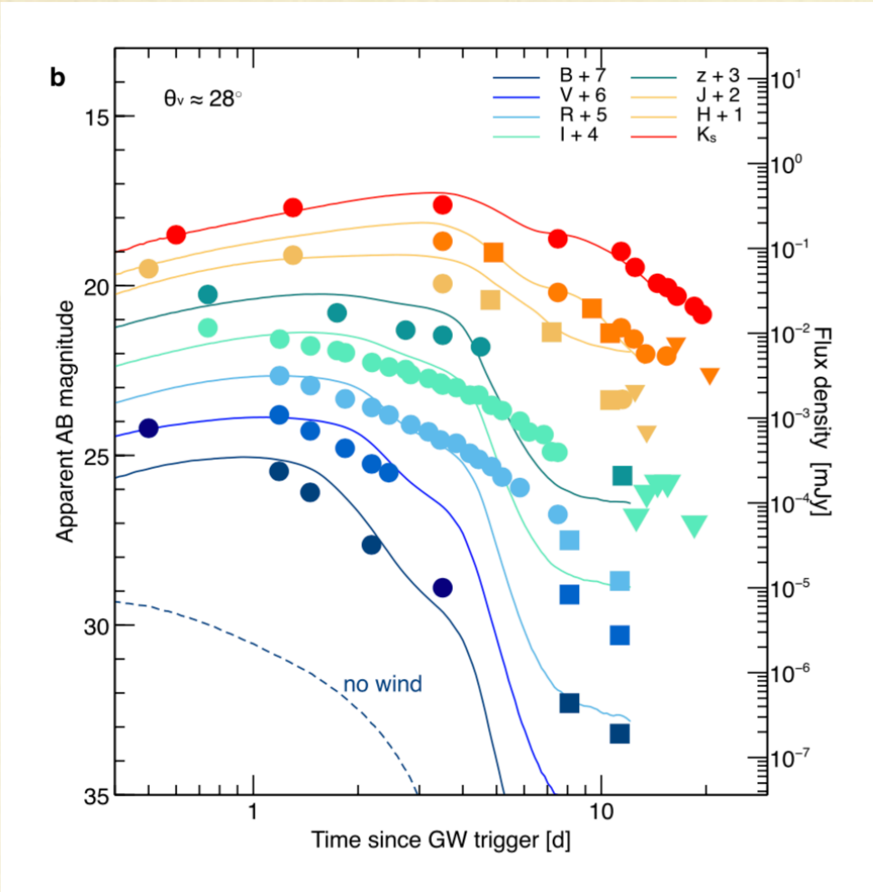
Ejecta Mass and Velocity

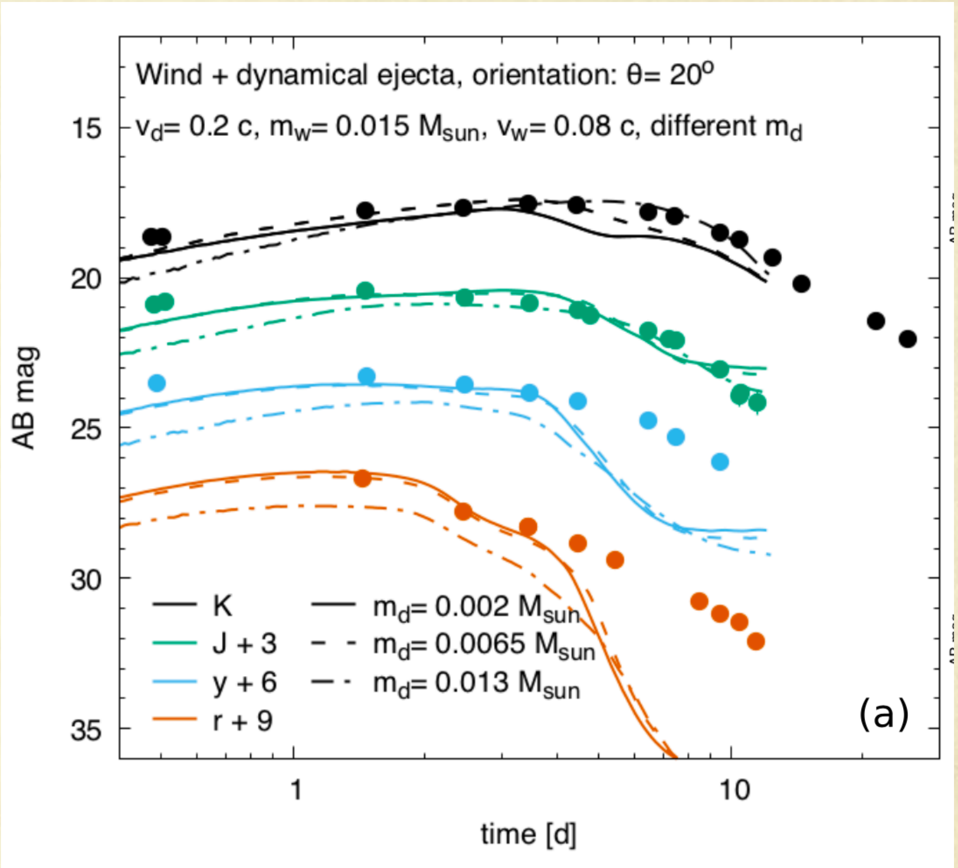


M = 0.05 Msun; v = 0.1c

Kasliwal et al. (2017)

NIR Photometry
Ejecta Mass and Velocity



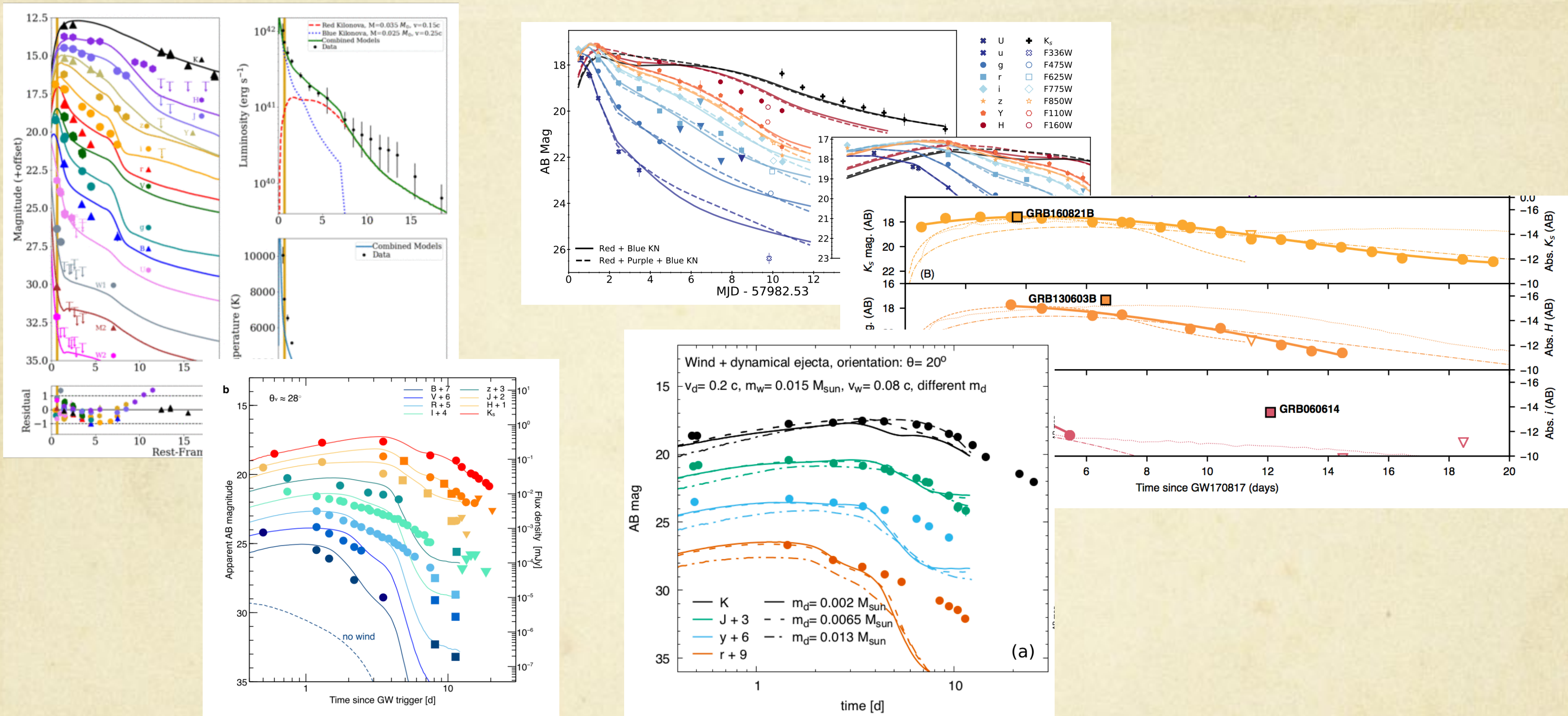


M = 0.002- 0.02 Msun; v = 0.2c

Troja et al. (2017), Tanvir et al. (2017), Smartt et al (2017),

NIR Photometry

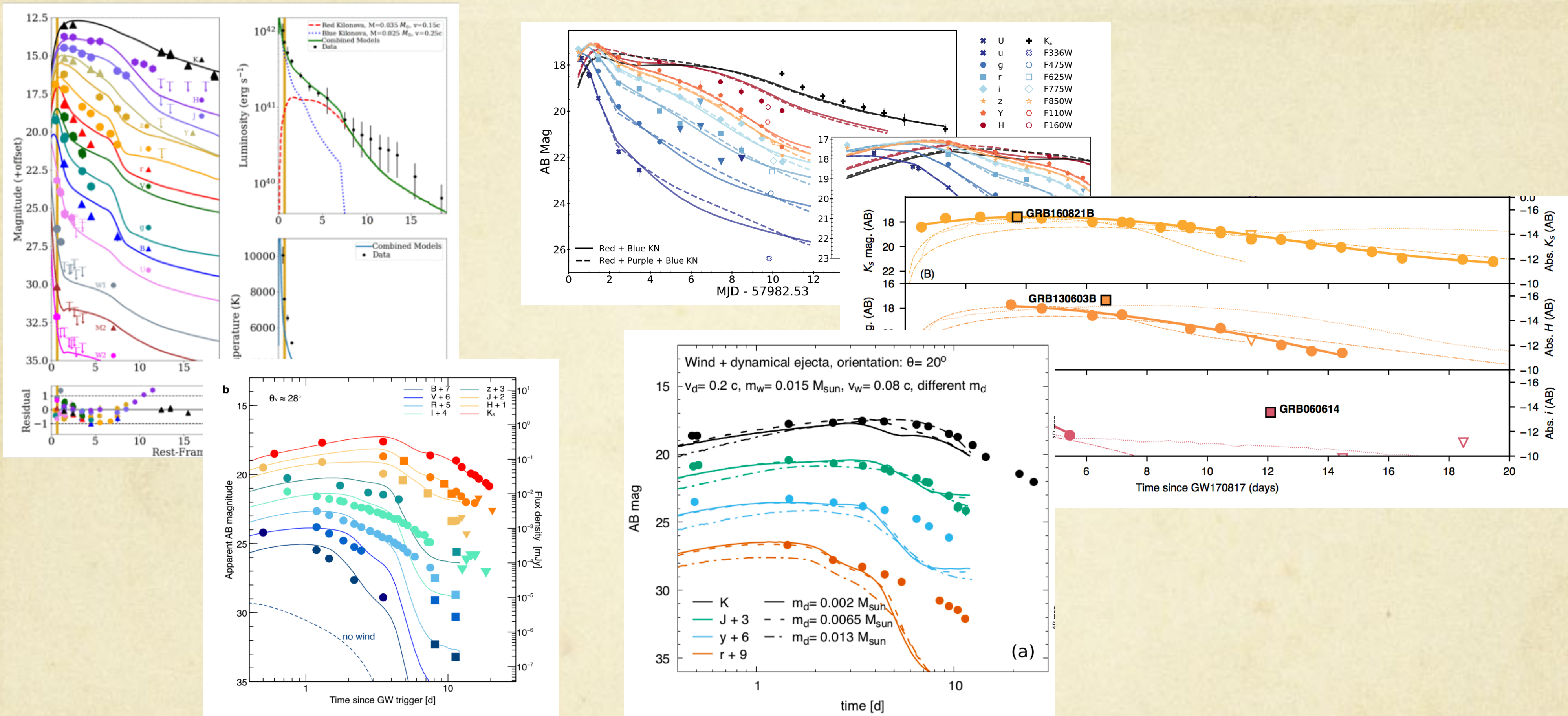
Ejecta Mass and Velocity



Caveats: thermalization efficiency, geometry.

NIR Photometry

Ejecta Mass and Velocity



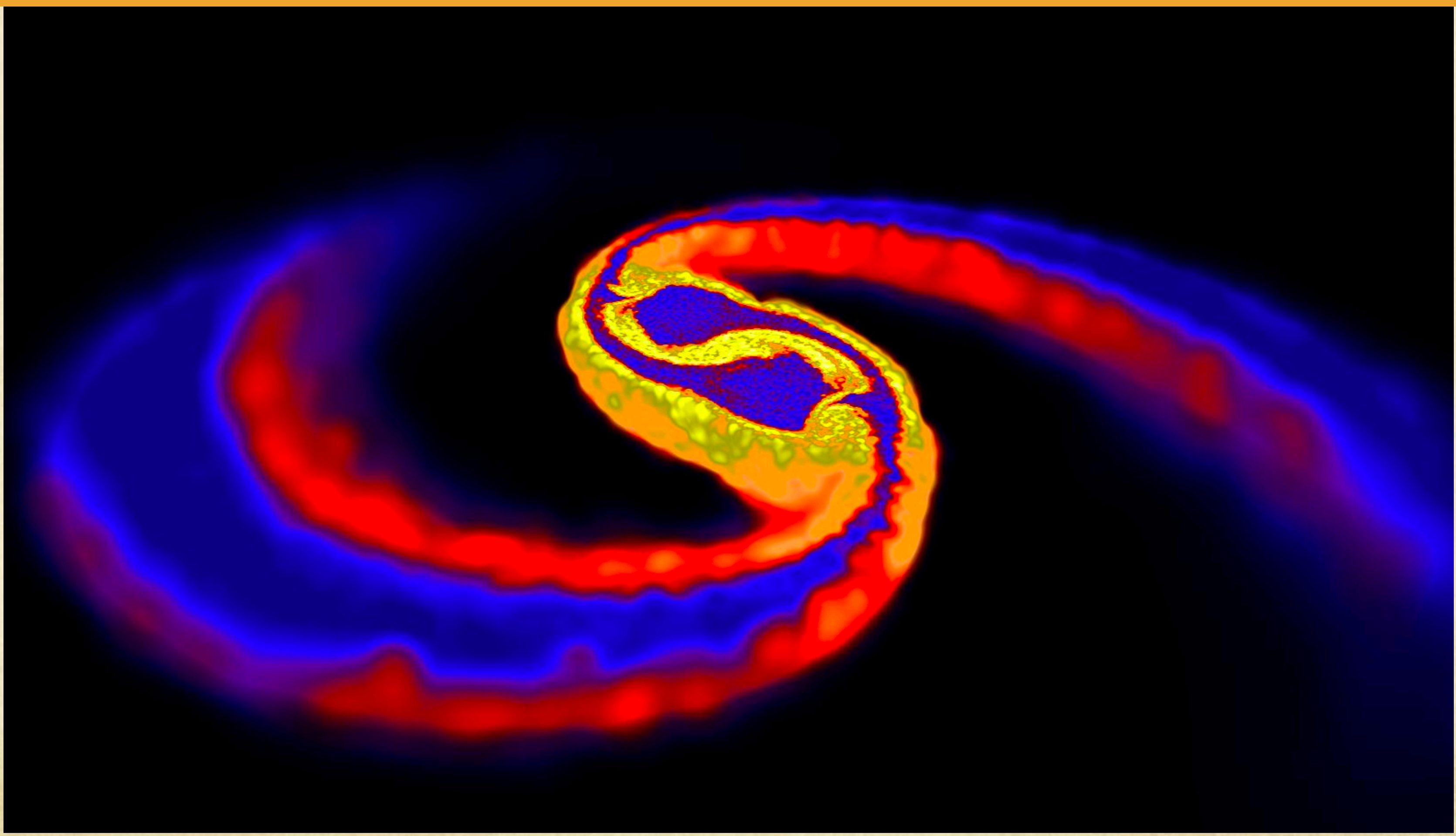
Caveats: thermalization efficiency, geometry.

"the red KN ejecta mass could be uncertain to a factor of ≈ 3 – 10" --Metzger 2017

NIR Photometry

Ejecta Mass and Velocity: Implications

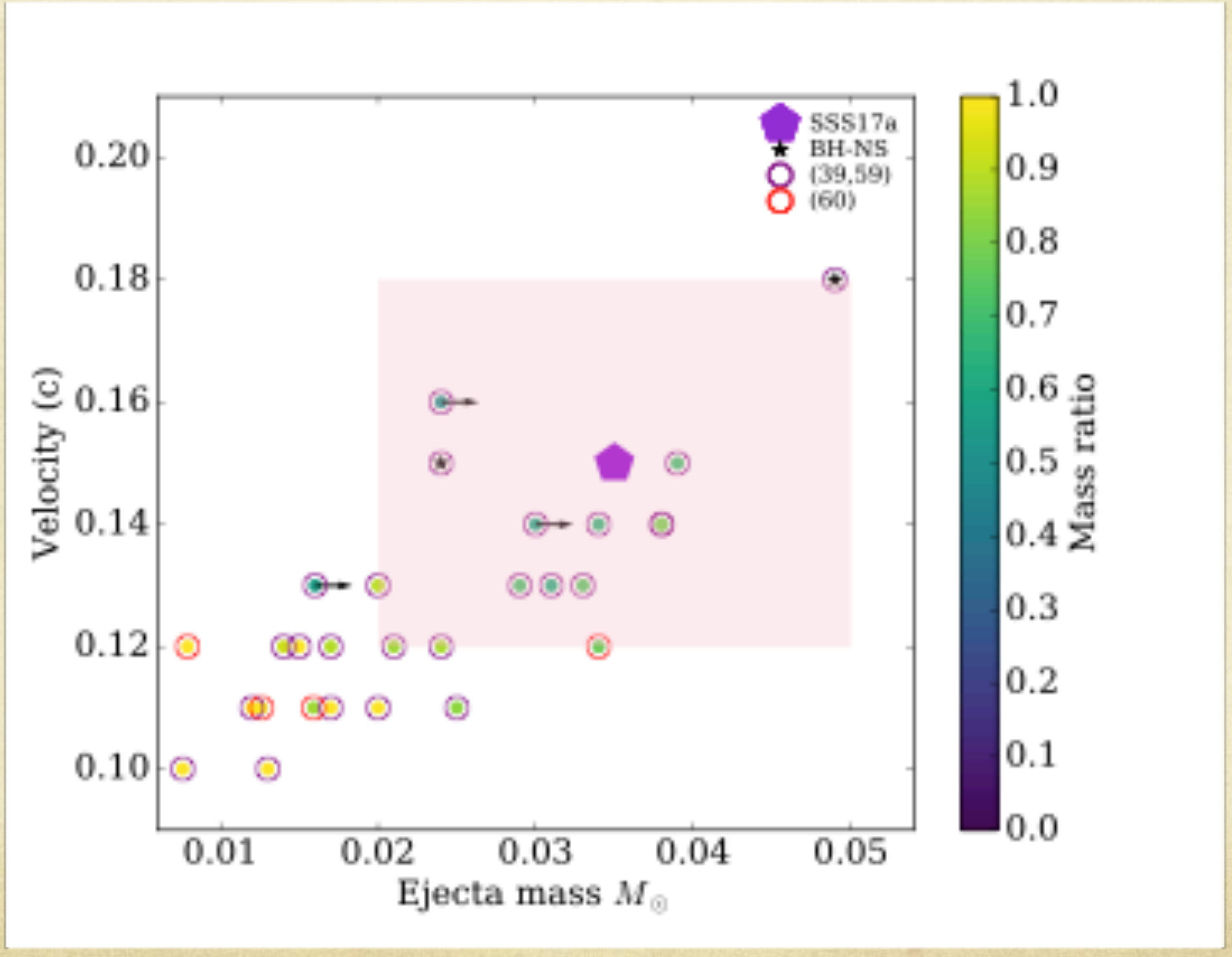
Dynamical Ejecta: typically < 10^{-2} Msun; v > 0.1



Credit: Daniel Price (U/Exeter) and Stephan Rosswog (Int. U/Bremen)

NIR Photometry

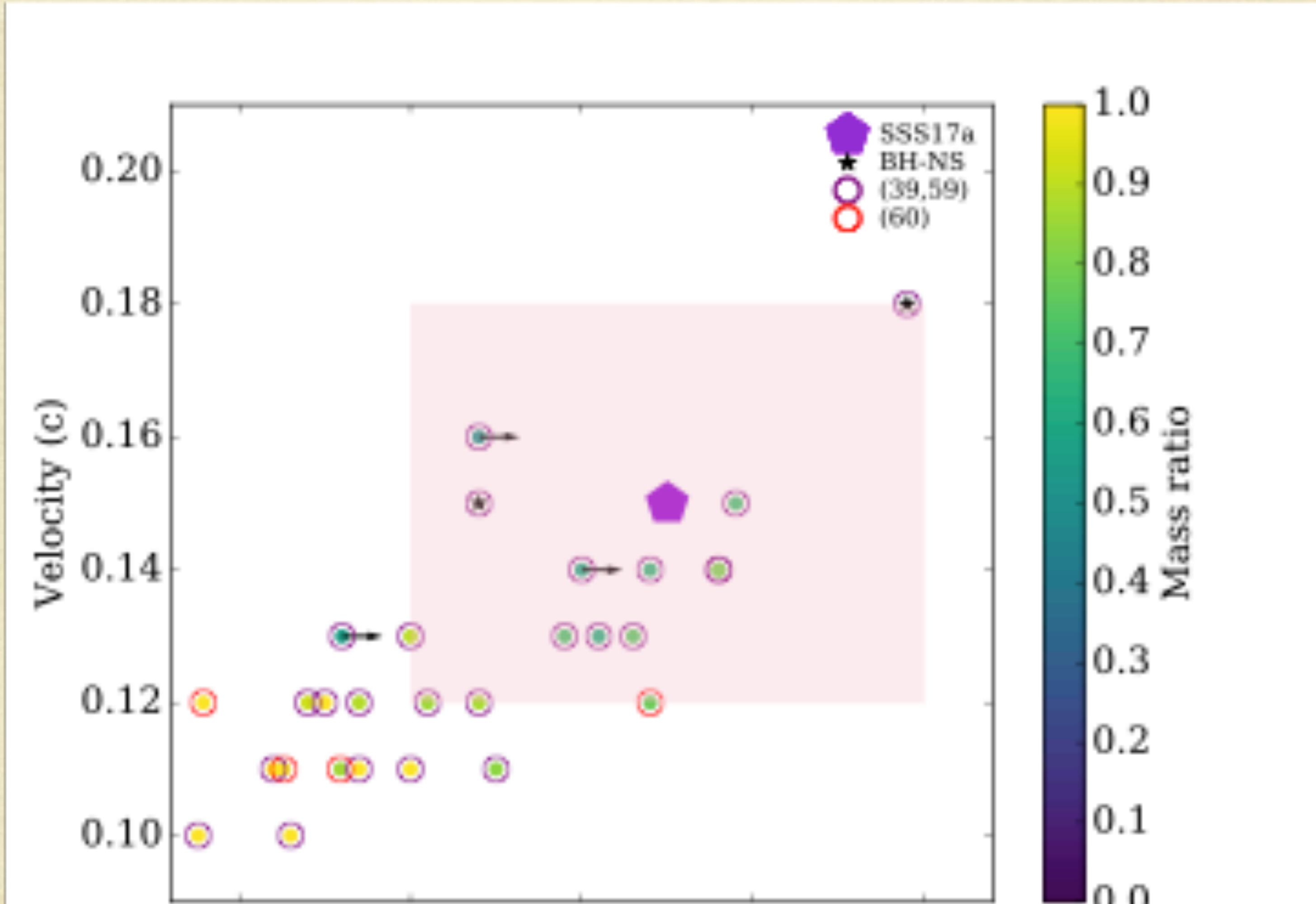
Ejecta Mass and Velocity: Implications



Kilpatrick et al. (2017)

NIR Photometry

Ejecta Mass and Velocity: Implications

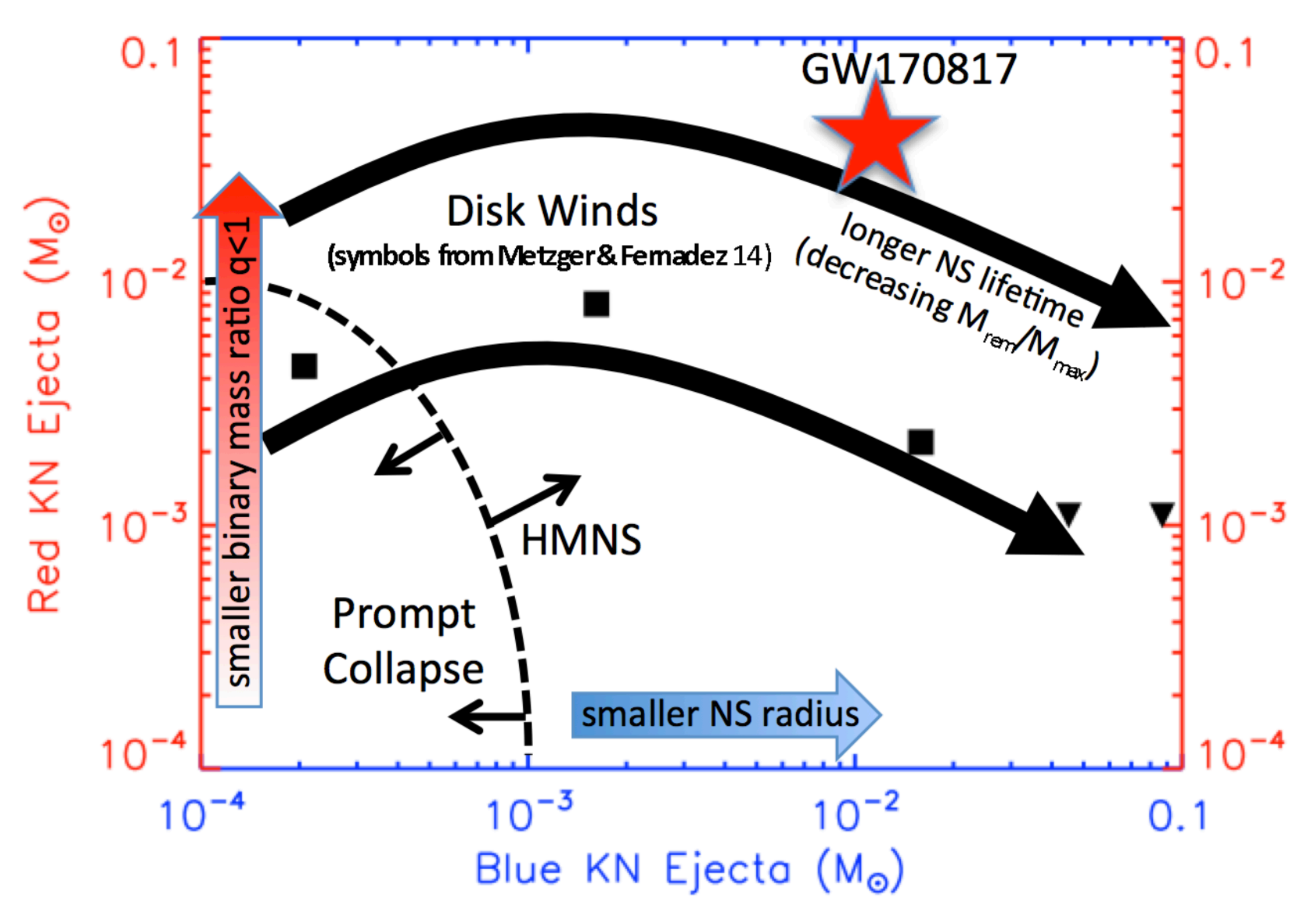


Caveat: Non-relativistic simulations.

Kilpatrick et al. (2017)

NIR Photometry

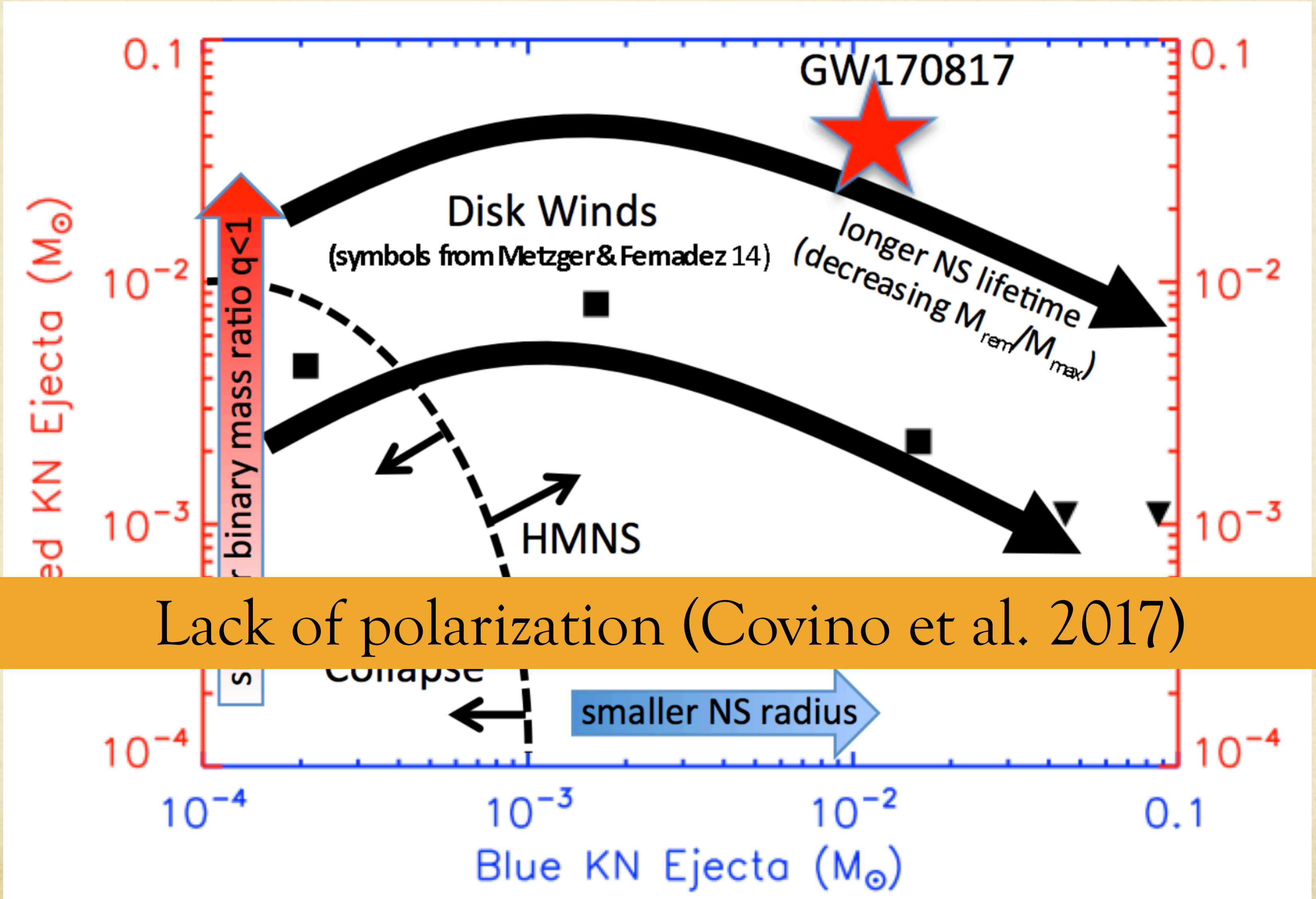
Ejecta Mass and Velocity: Implications



Metzer (2017)

NIR Photometry

Ejecta Mass and Velocity: Implications



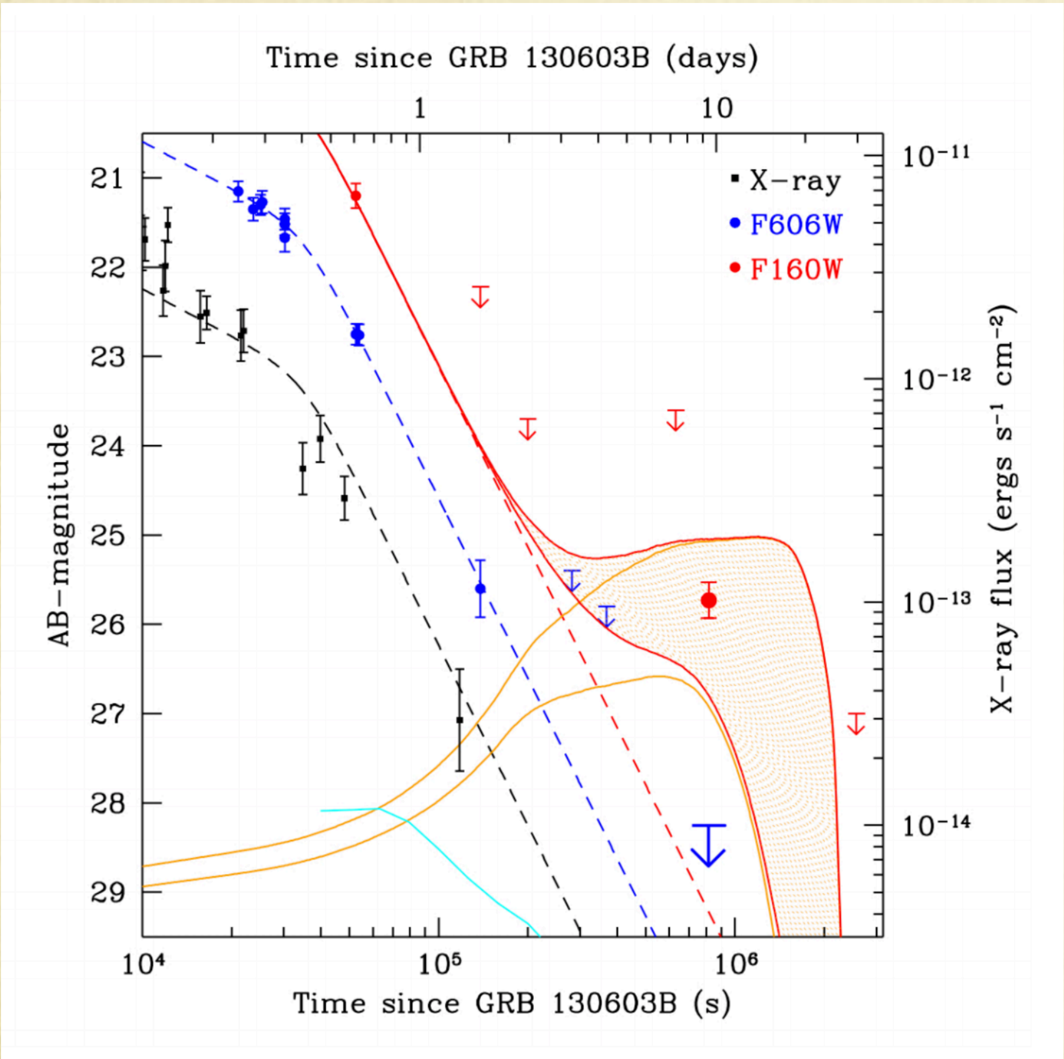
Lack of polarization (Covino et al. 2017)

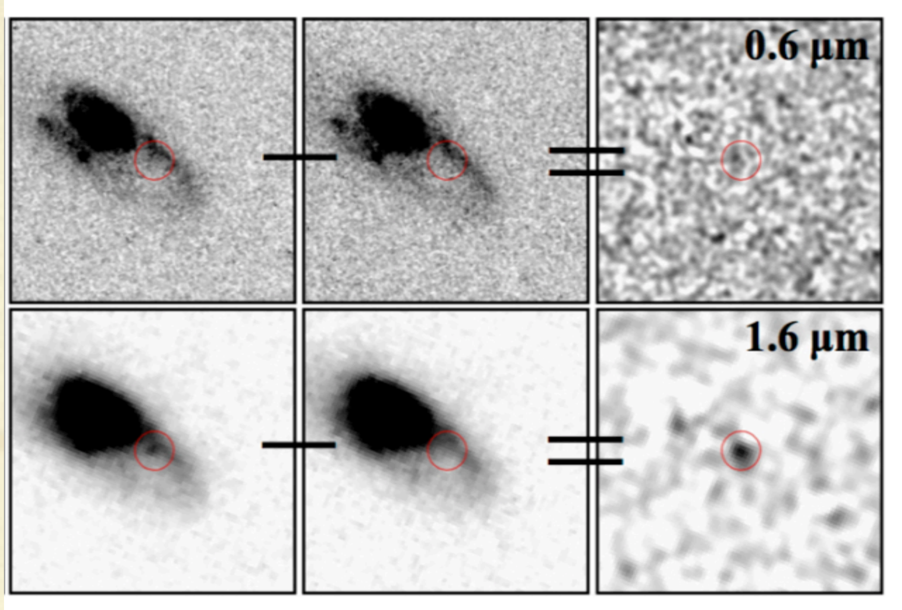
Metzer (2017)

NIR Photometry
The "SN1987A Effect": Is GW170817 a Weirdo?

NIR Photometry

The "SN1987A Effect": Is GW170817 a Weirdo?

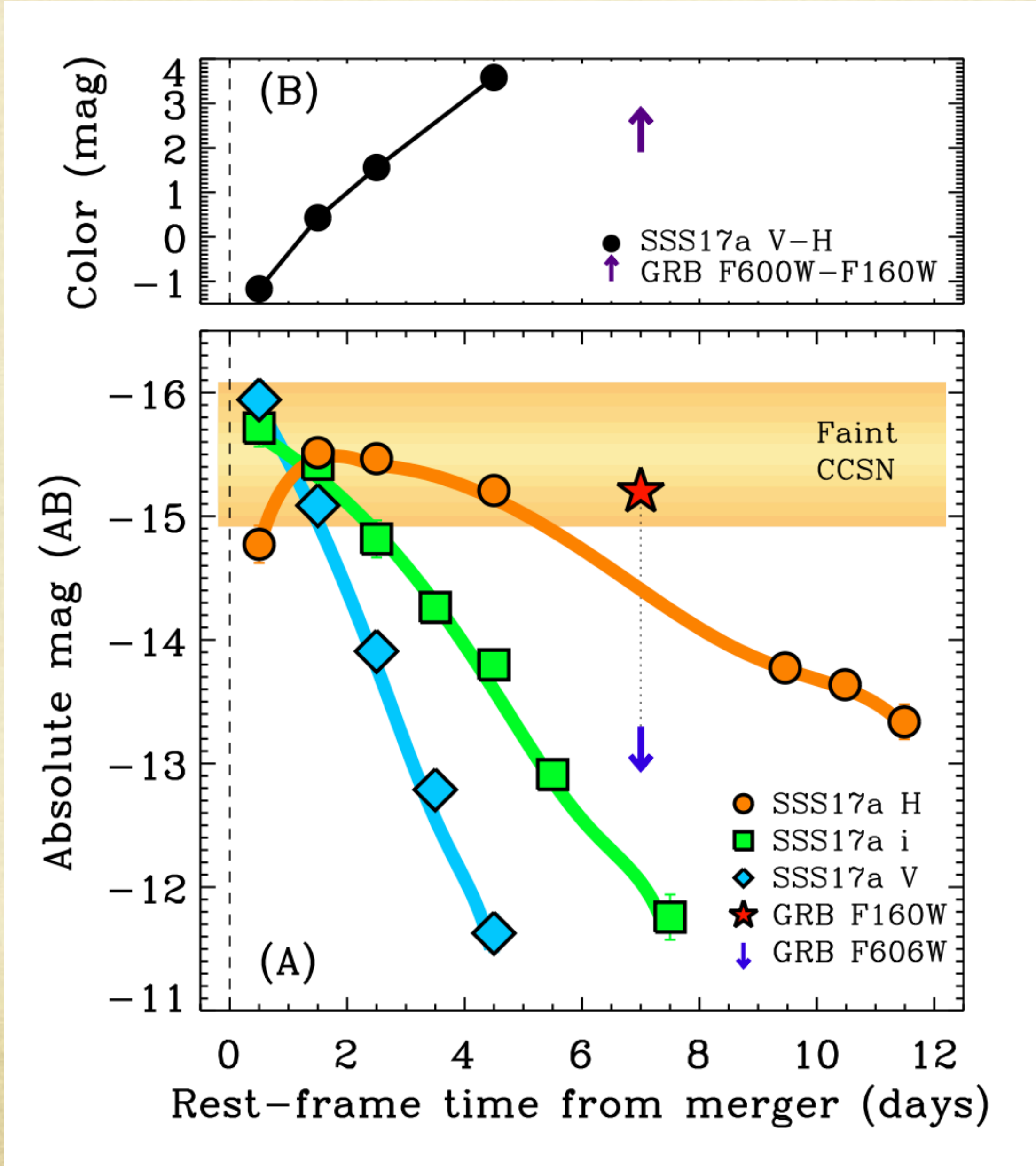




Tanvir et al. 2013,
Berger et al. 2013

NIR Photometry

The "SN1987A Effect": Is GW170817 a Weirdo?



Drout et al. (2017)

NIR Photometry

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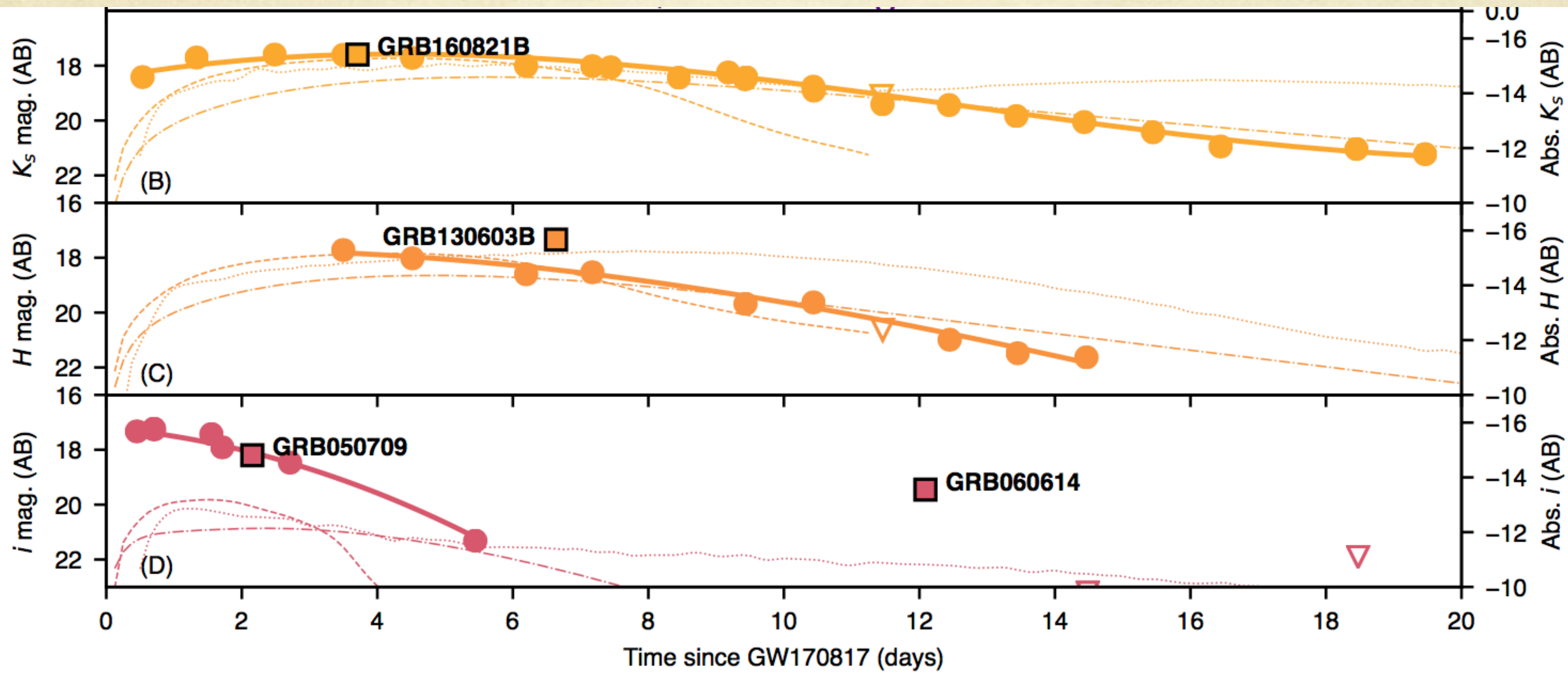

Kasliwal et al. (2017)

NIR Photometry

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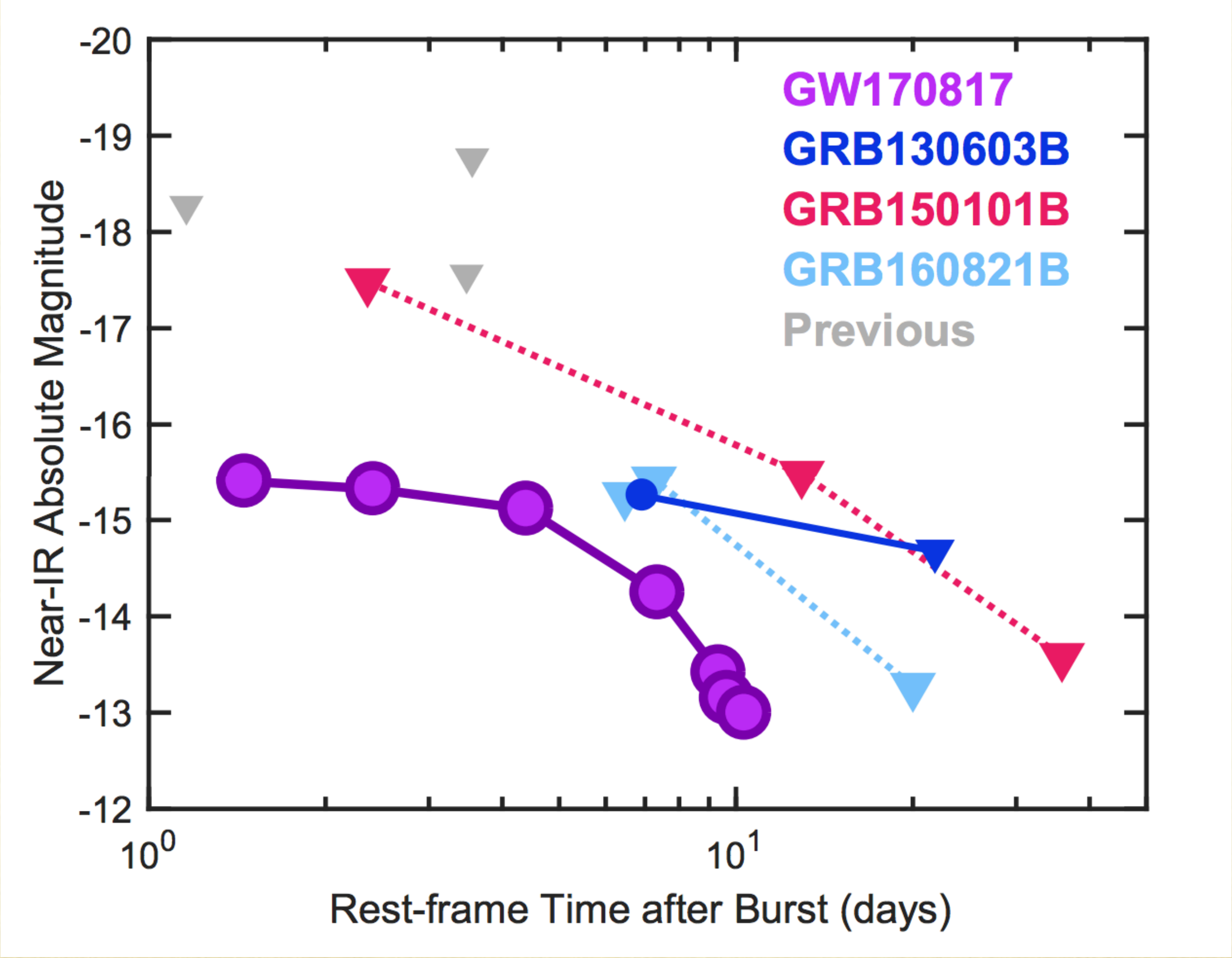
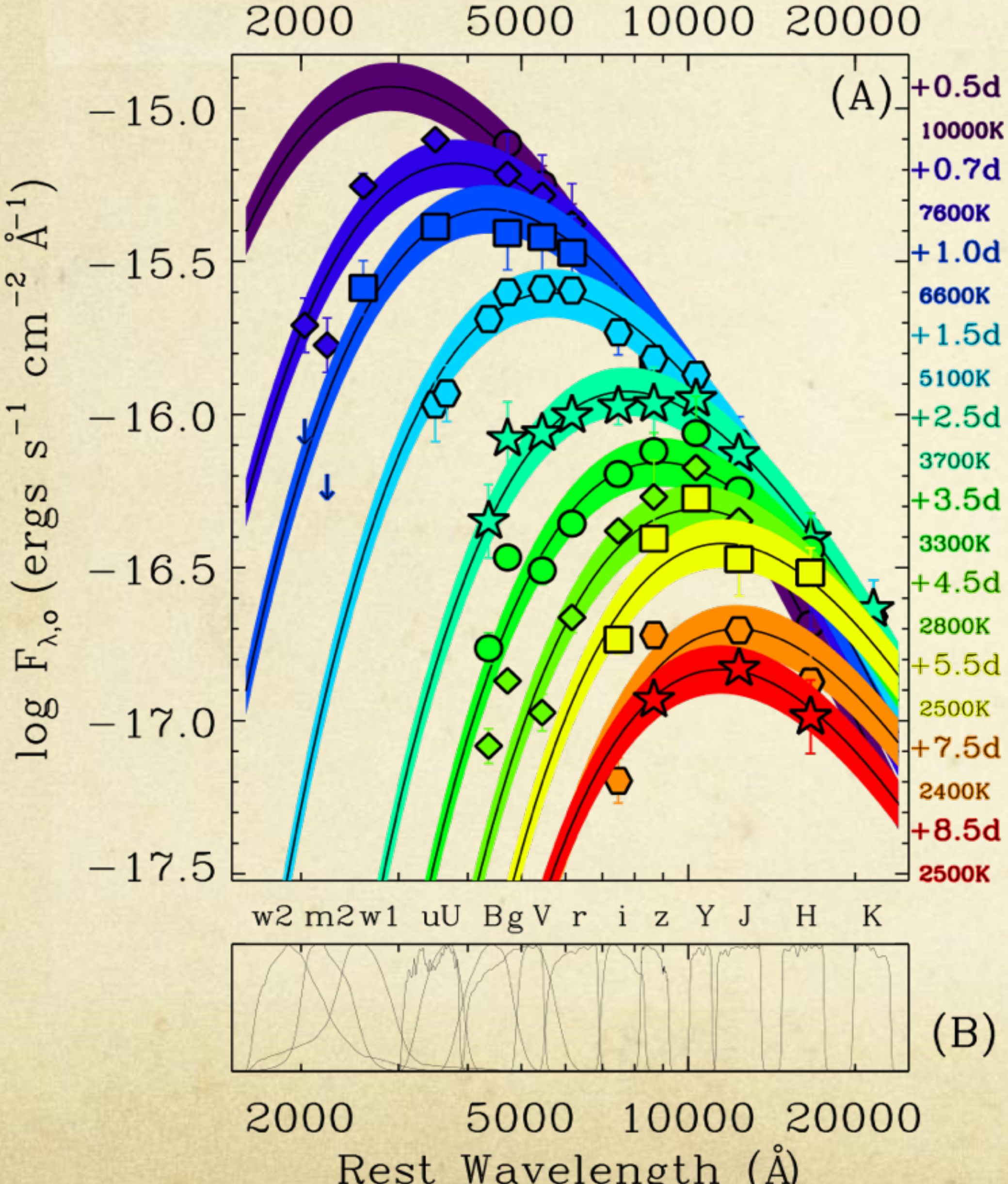
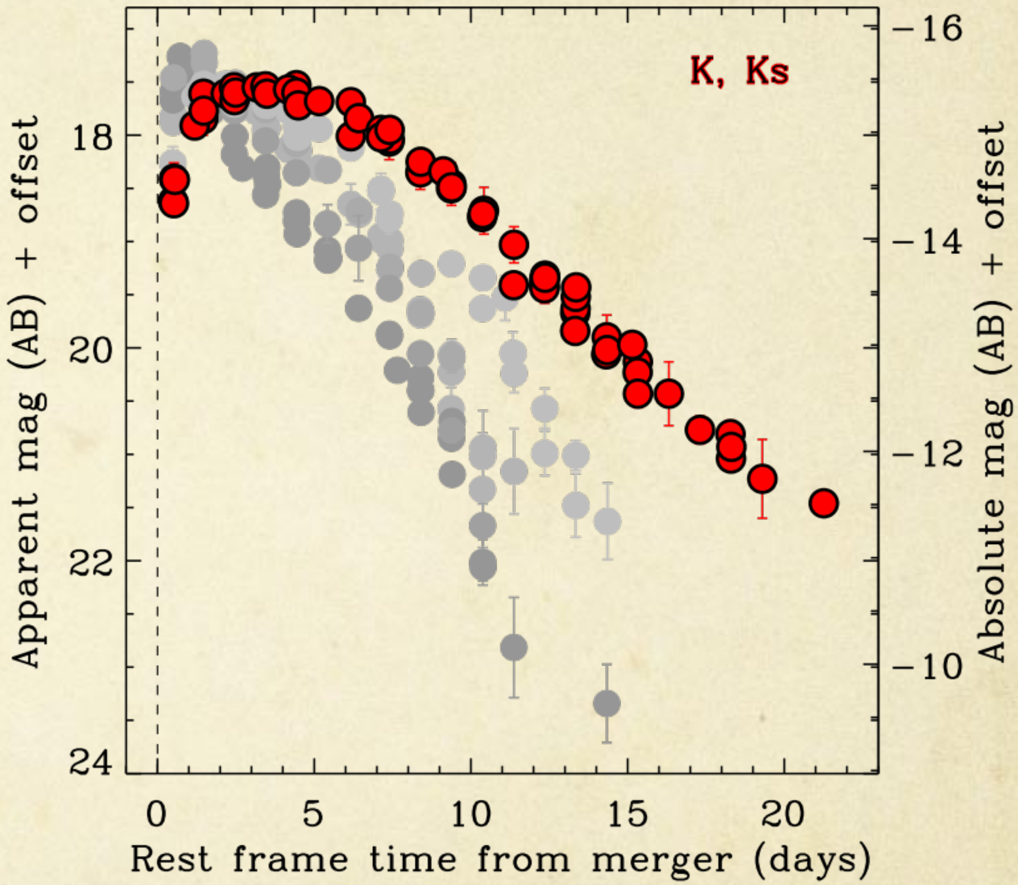


Fong et al. (2017)

NIR Photometry





Sometimes What Glitters *is* Gold

Infrared Photometry of GW170817

Image Credit: Robin Dienel/Carnegie Observatories