A Kilonova Associated with the Short GRB 130603B

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WFC3/UVIS F606W *V*
WFC3/UVIS F814W *I*
WFC3/IR F160W *H*

LGRBs are Decisive

- Long bursts (LGRBs) are largely found on rapidly star-forming irregular galaxies (Fruchter+1999, Bloom +1999...)
- LGRB hosts are generally dominated by extremely young stellar populations (<10 Myr) (Levesque+ 2010) and are largely metal poor ($\lesssim$ 1/3 solar) (Modjaz+ 2008)
- LGRBs are preferentially found on brightest regions of their hosts (Fruchter et al. 2006)
- Most, if not all LGRBs, are associated with Type Ic SNe (Hjorth + 2003, Stanek + 2003 ...)

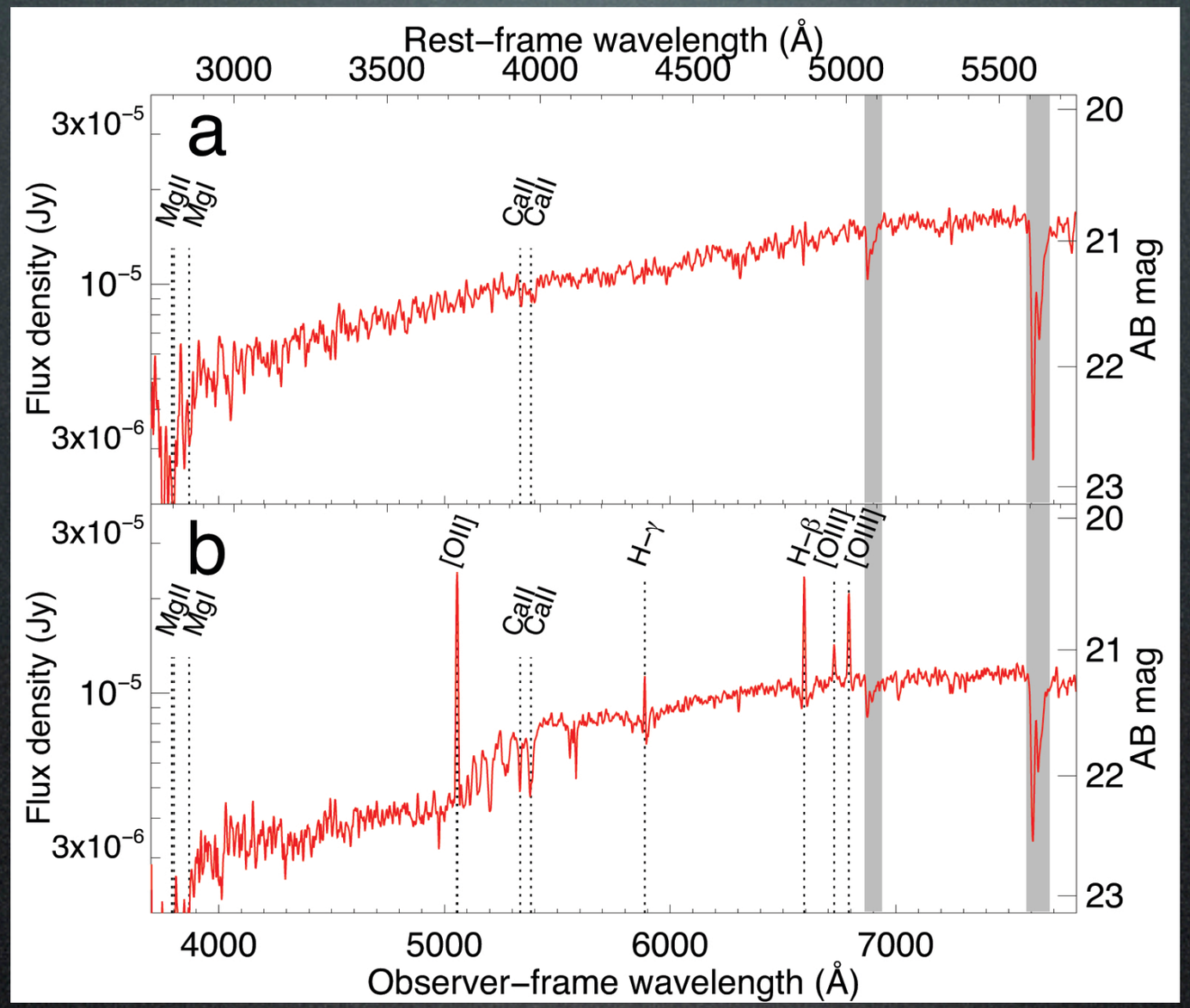
SGRBs Are Tentative

- SGRBs are found in all types of galaxies, from star-forming dwarfs to ellipticals (Fox + 2005, Bloom + 2005)
- Stellar populations of hosts have typical ages of few hundred Myrs (Liebler & Berger 2010)
- No SGRBs are associated with SNe (to very strong limits in many cases)
- SGRBs are widely distributed on hosts (Berger & Fong 2010); ~ 10% may be hostless

You say Macronova, I say Kilonova

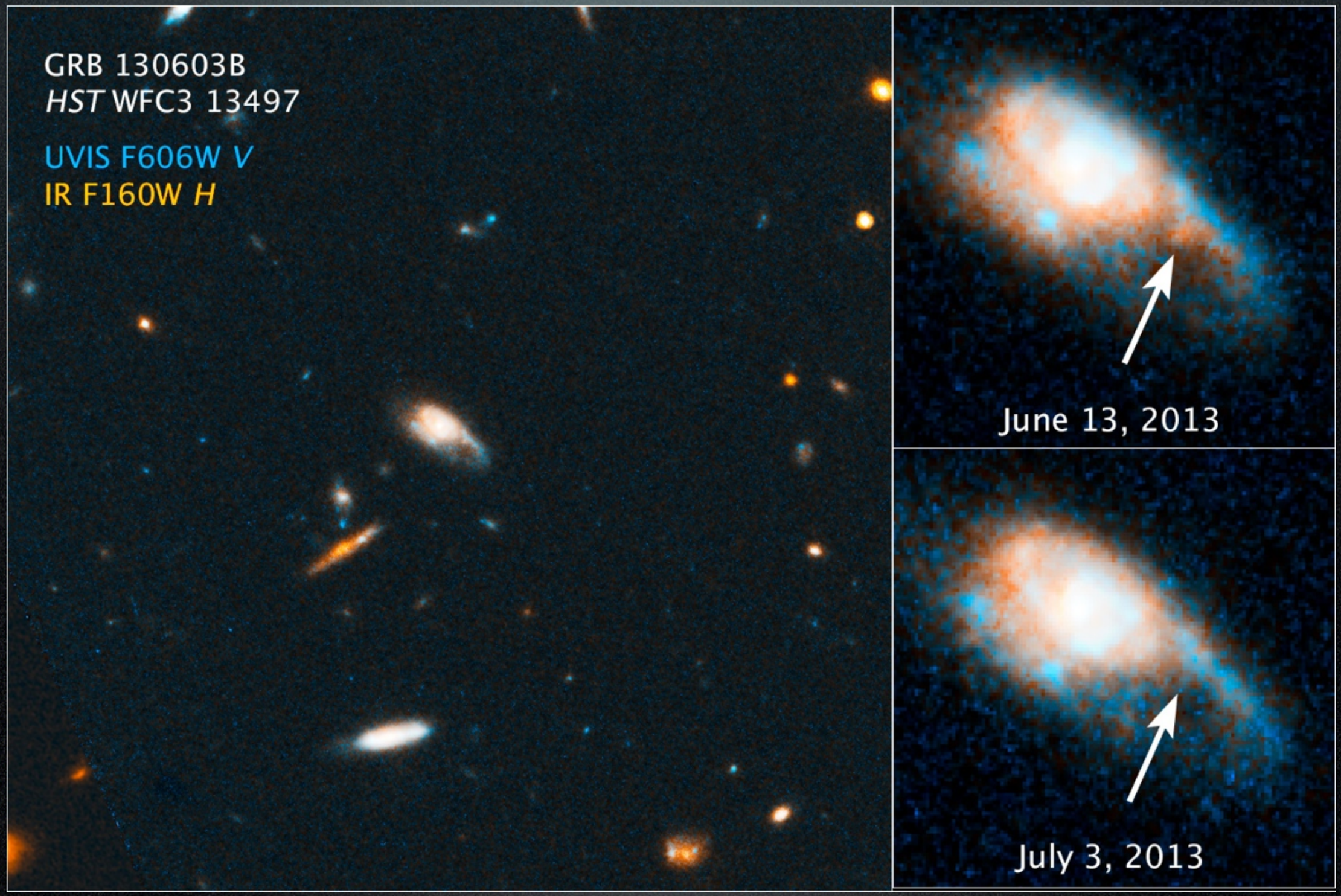
- Merging neutron stars should throw out few percent of their mass as tidal tails -- this material would be hot, and neutron rich. (Eichler + 1989, Li & Paczynski 1998,)
- No search had yet found such a “nova”
- Barnes and Kasen (2013) proposed the nova would be very red due to extraordinary optical depth of r-process ejecta.

First SGRB Host Absorption Spectrum of GRB 130603B

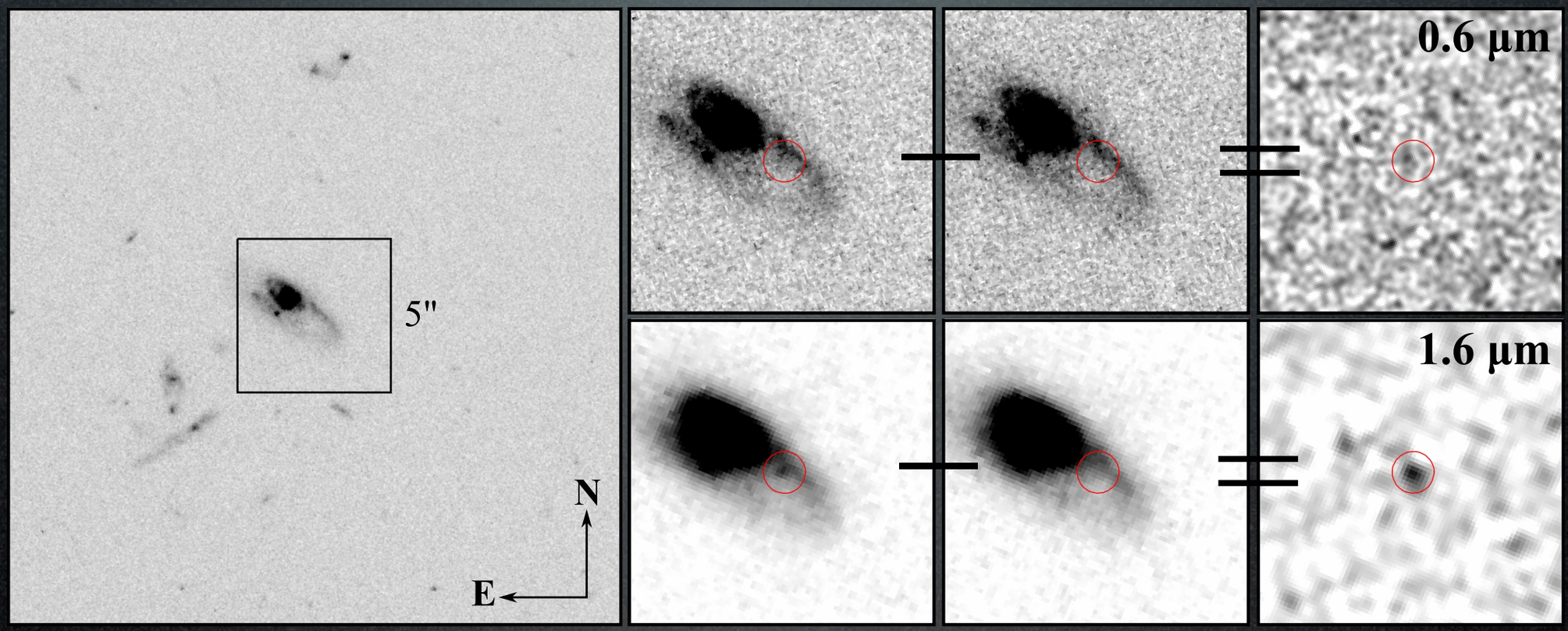


de Ugarte Postigo et al. 2013

Environment of GRB 130603B

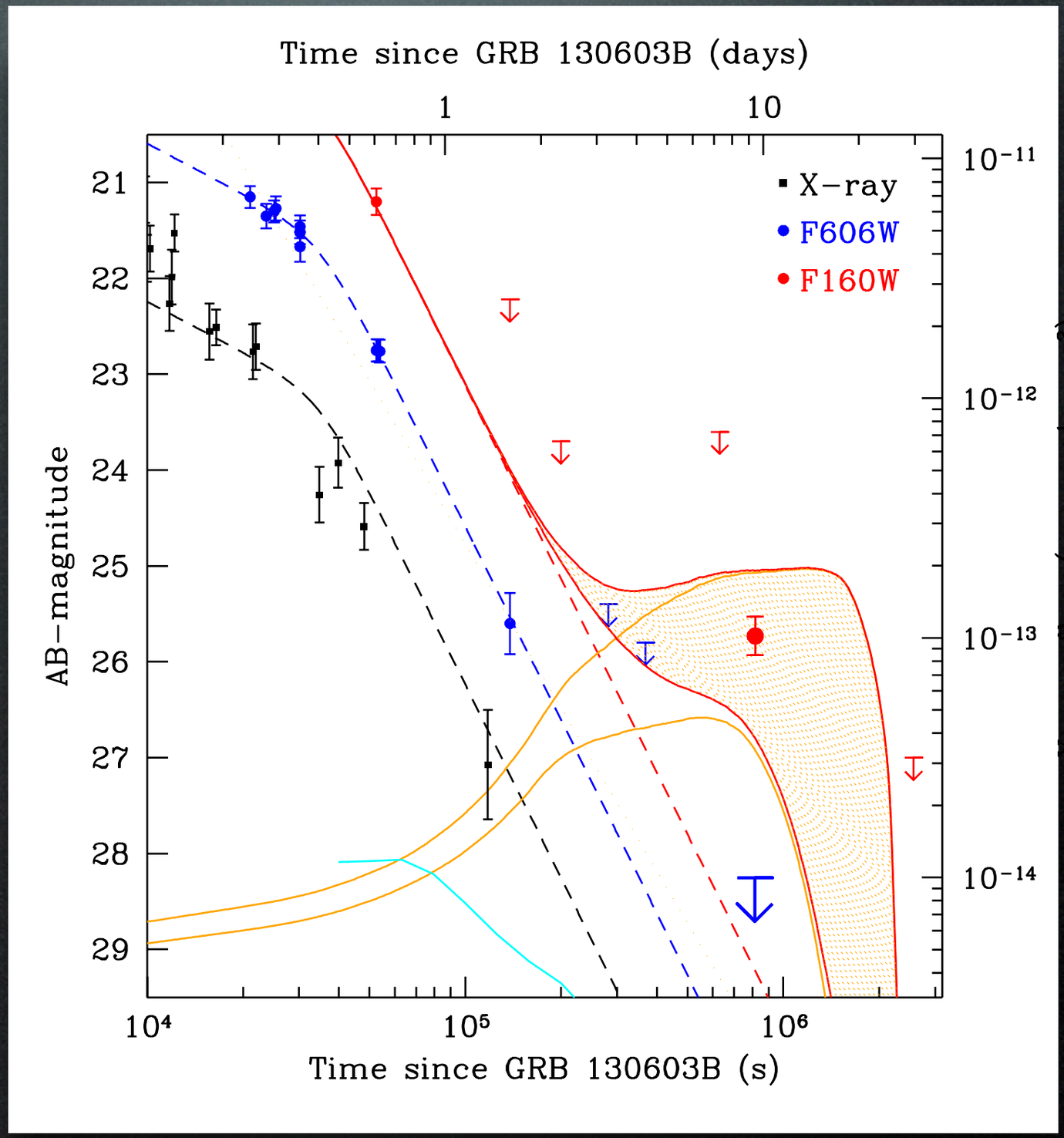


SGRB 130603B in Black and White



GRB 130603B Light Curve

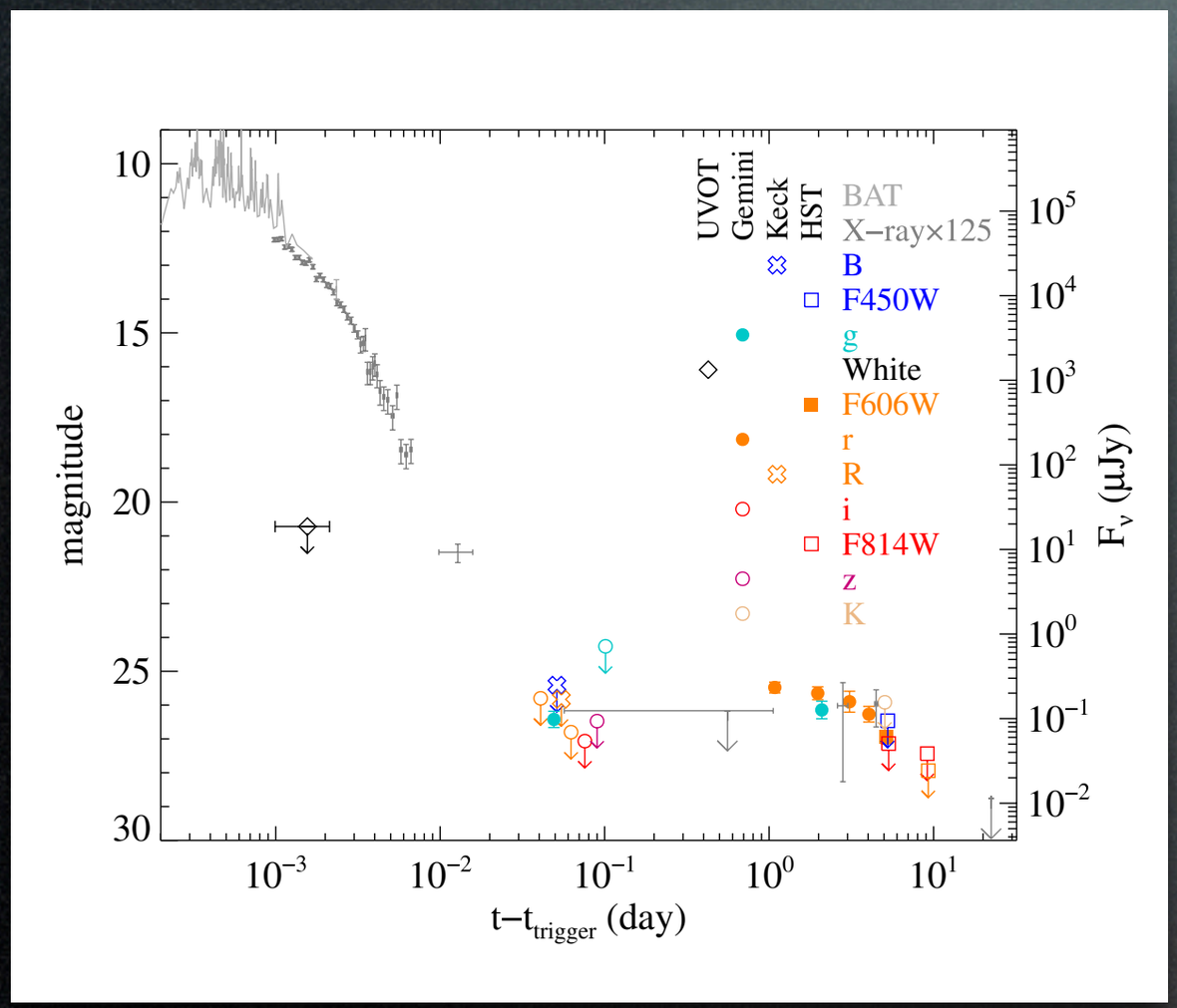
Tanvir et al. 2013



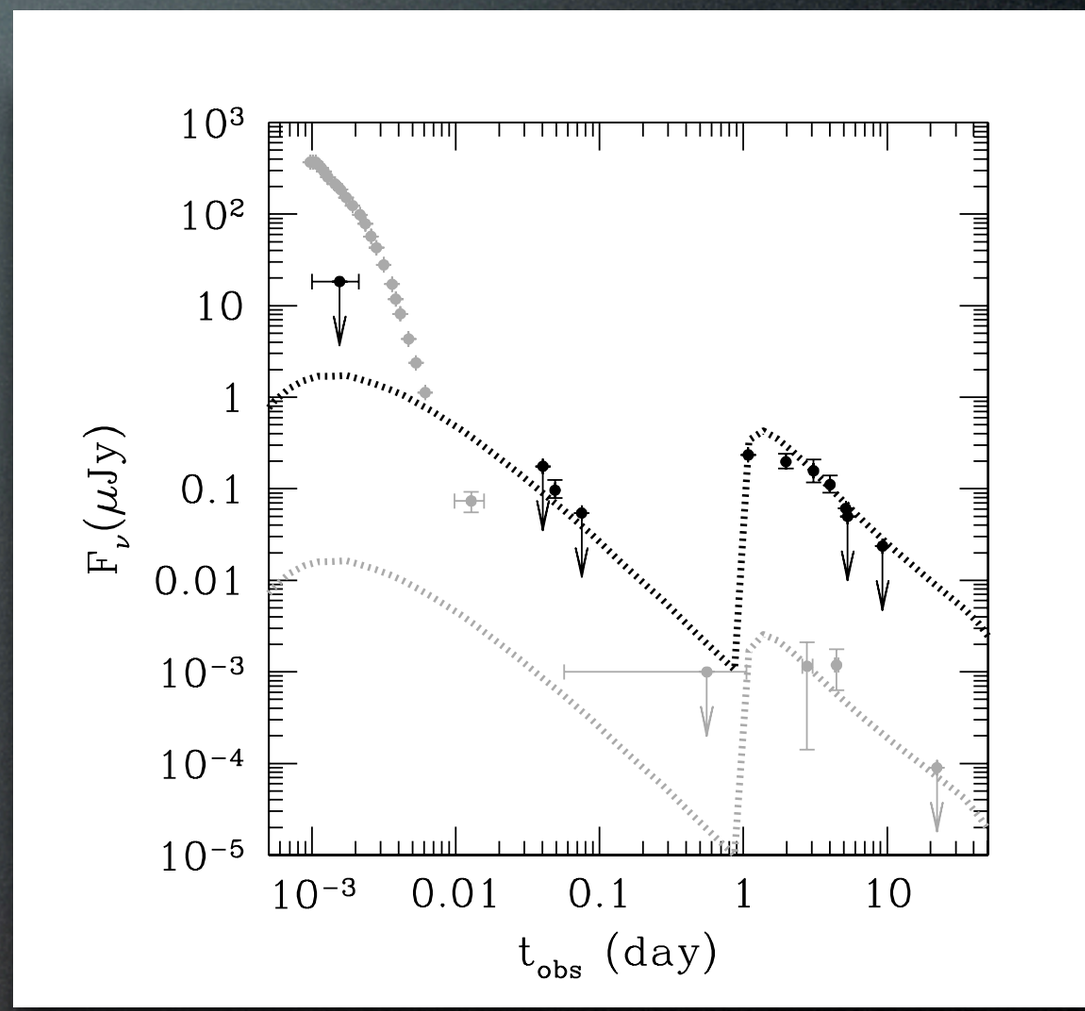
Do We Say Kilonova?

- Absolute magnitude of J=-15.35 at 7 days is in good agreement with KN models -- and makes it in luminosity at least a “kilonova”
- Timescale of “bump” consistent with KN predictions
- But our data are not as constraining as one might like

GRB 080503

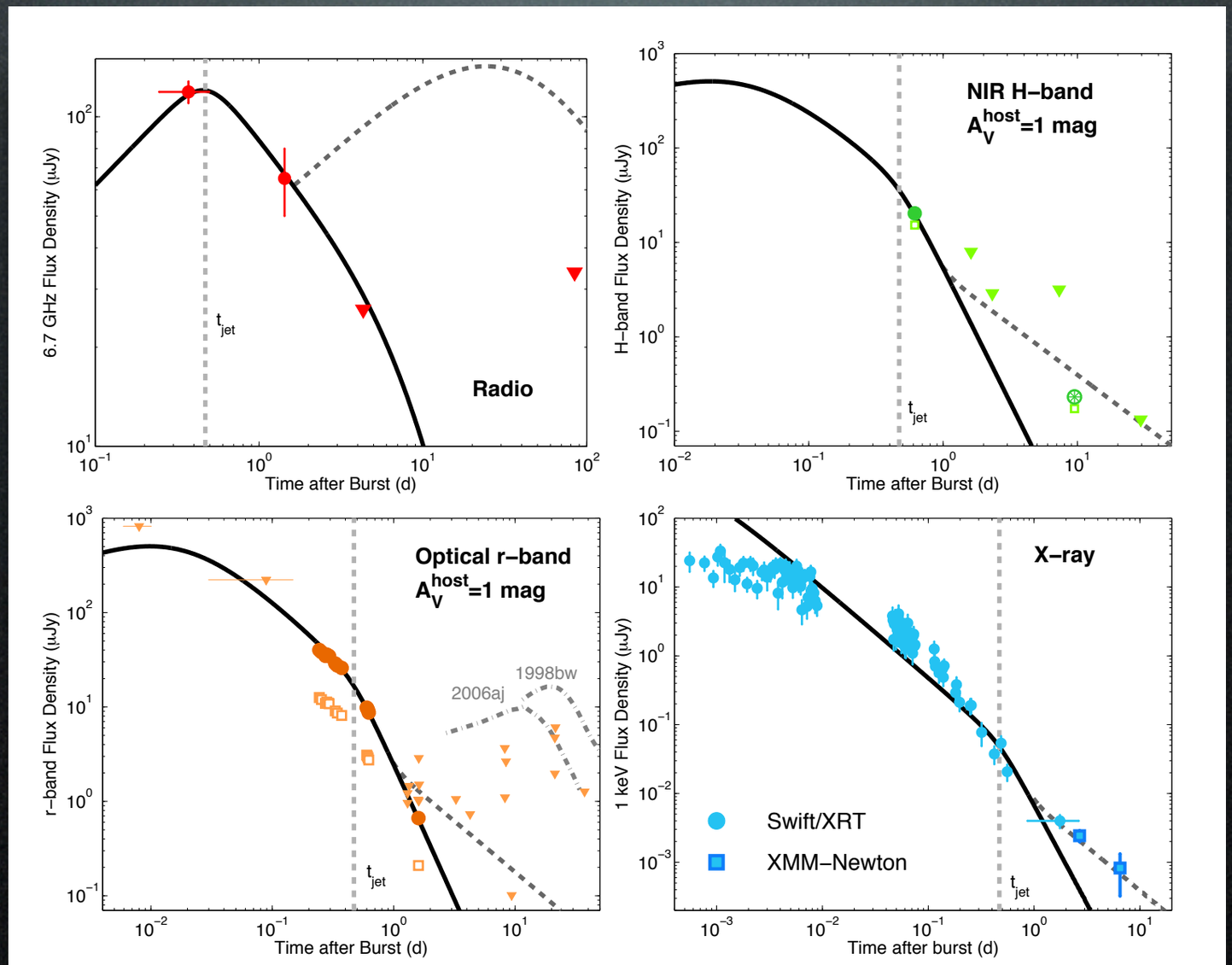


Perley et al. 2009



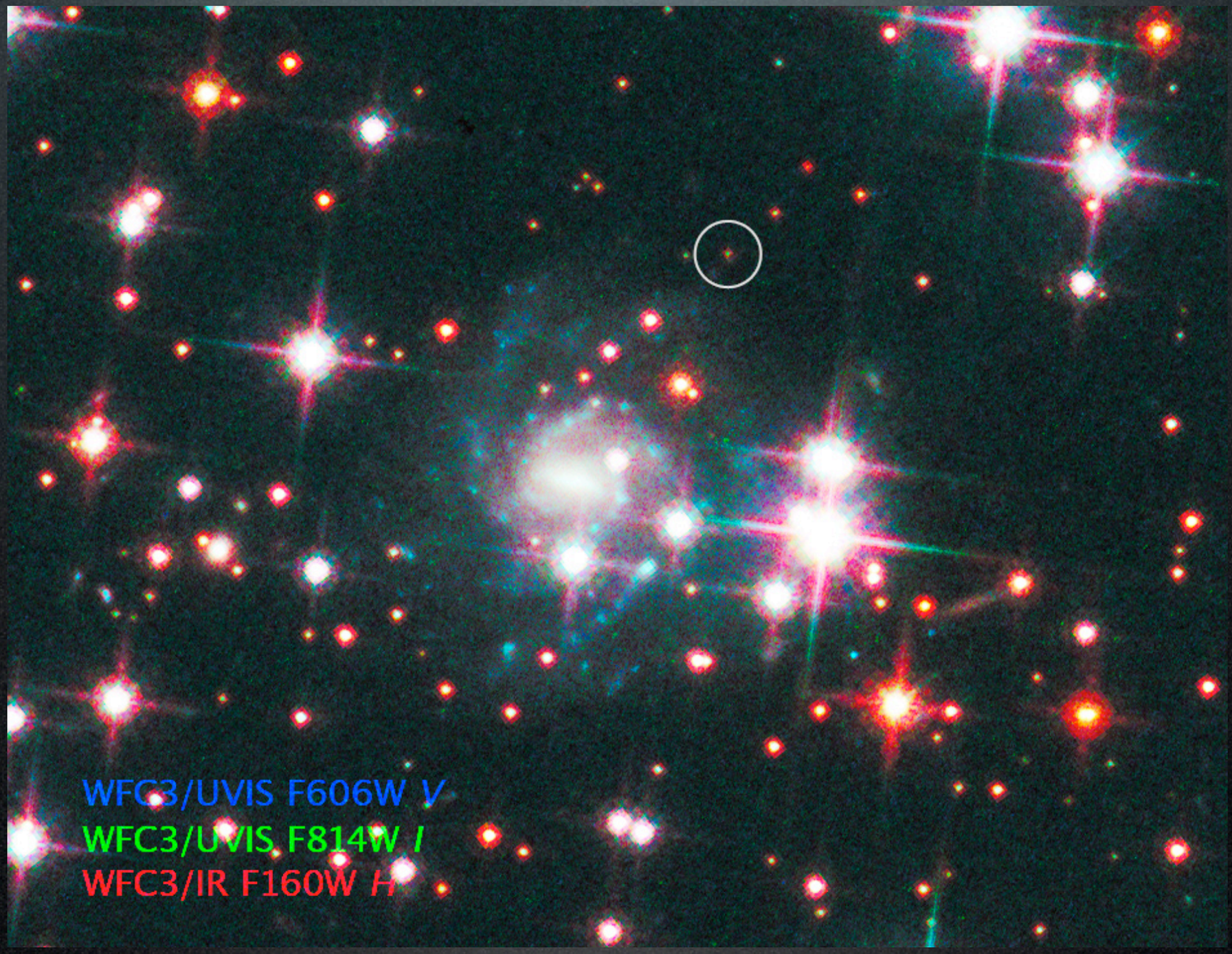
Hascoët et al. 2012

Et tu, 060313B?



Fong et al. 2013

The Nearest(?) SGRB



GRB 080905a z=0.12? (480 Mpc)

Kilonovae as Markers

- Advanced LIGO should find NS mergers out to ~200 Mpc
- Will have error circles of 10s of square degrees
- But at 200 Mpc, 130603B would have had J≈21, I~22-25. Can be found from ground but will likely require image subtraction (so not trivial) and large aperture (Subaru, LSST?)

Conclusions

- The simplest explanation for our observations is a kilonova.
- Our results do not eliminate the possibility of a rare afterglow phenomenon, but we appear to be confirming a PREdiction.
- There is a good chance we will have an opportunity to repeat the experiment within another eighteen months.