

Preliminary Results of PHOENIX NLTE Spectra of Toy Kilonova Models

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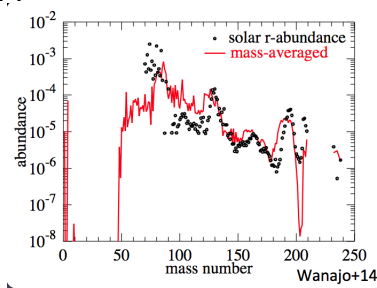
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2017-08-02

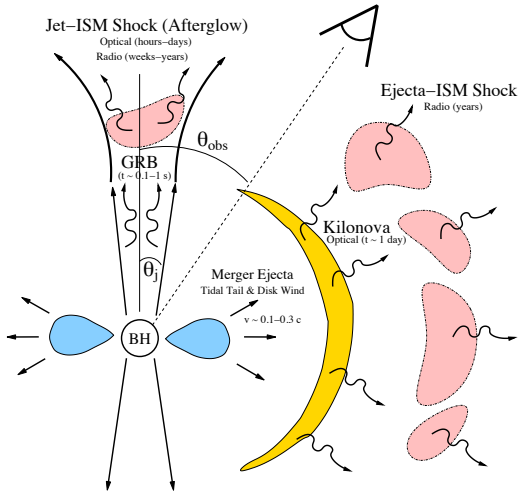
Merging NS

- ▶ Possible R-process site
 - ▶ Lattimer+ 1977



- ▶ EM Counterpart of GR Wave
Li & Paczynski 98, Kulkarni 05, Metzger+10

Basic Picture



(From Metzger & Berger, 2012)

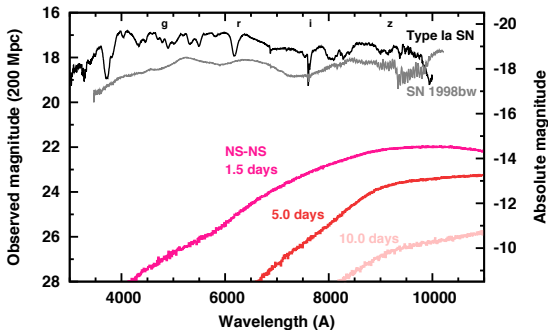
Bringing Coals to Newcastle

- ▶ Heard a talk by Masaomi Tanaka
- ▶ Asked about effect of edges
- ▶ Continua not included in Tanaka+ work
- ▶ Thought to use PHOENIX
- ▶ Put an excellent undergraduate, Patrick Vallely on project
- ▶ Have only proof of concept results

Event Rate/Brightness

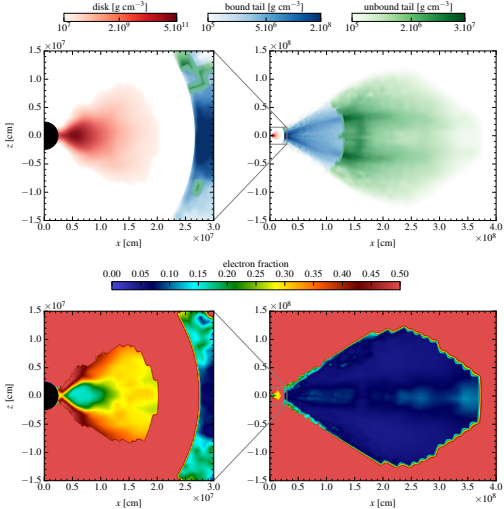
Tanaka+16

► $R_{\text{NSM}} \approx 1000 \text{ Gpc}^{-3} \text{ yr}^{-1}$

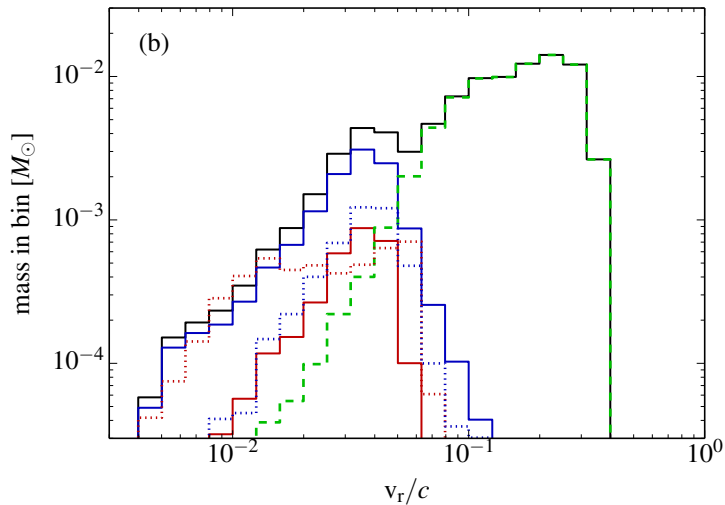


Fernández+17

BH-NS mergers

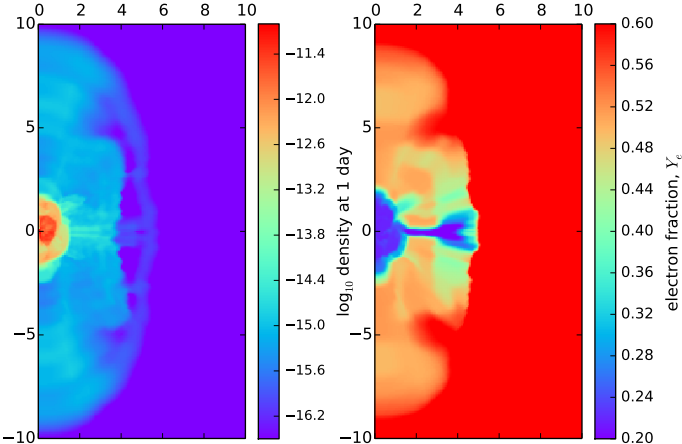


Relativistic Velocities



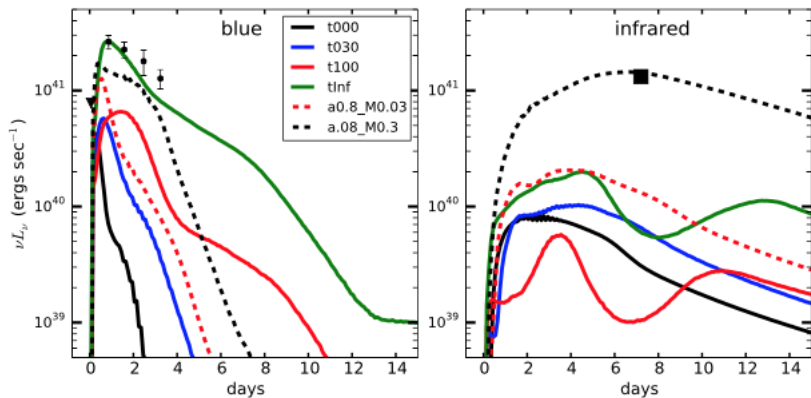
Disk Wind Structure

Kasen+15



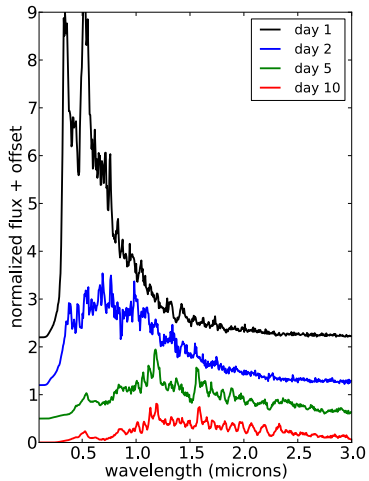
Light Curves

Kasen+15



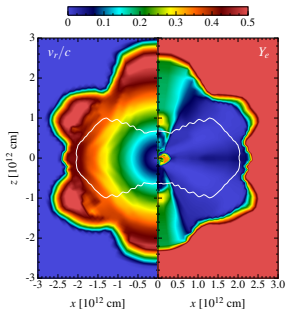
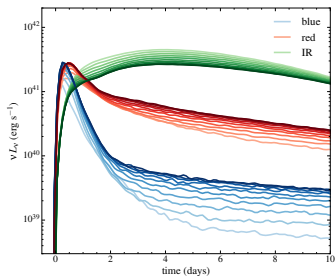
Spectra

Kasen+15



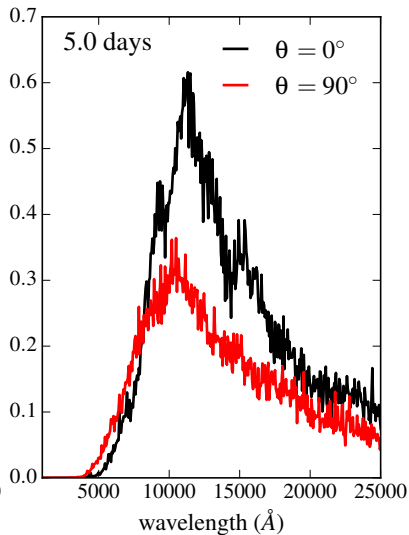
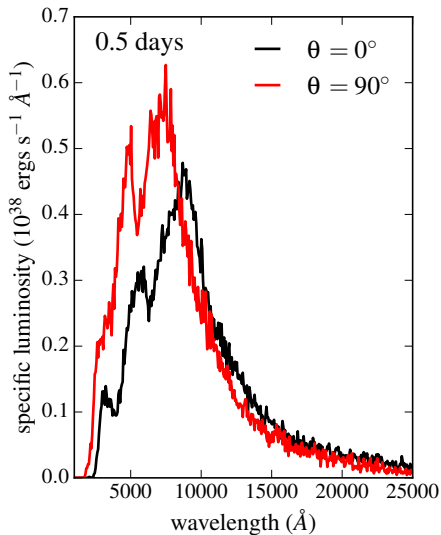
Light Curves

BH-NS Merger Fernández+17



Spectra

BH-NS Merger Fernández+17



1D/3D Radiative Transfer

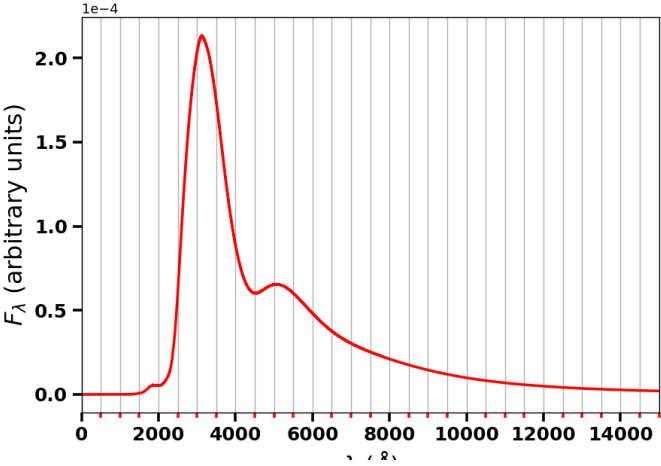
- ▶ PHOENIX/3D: general detailed 3D modeling of radiation fields in gaseous environments (stars, planets, supernova, AGN, rooms).
 - ▶ 3D spatial problem is 6D or 7D computational problem since must solve full phase-space solution of Boltzmann Equation
 - ▶ Full Special and General Relativistic
- ▶ Non-local thermodynamic equilibrium (NLTE)
- ▶ Model atoms for Lanthanides/Actinides
- ▶ multi-layered/scale domain decomposition
 - ▶ one for the data
 - ▶ one for the wavelength
 - ▶ another internal one for the RT

Preliminary Results

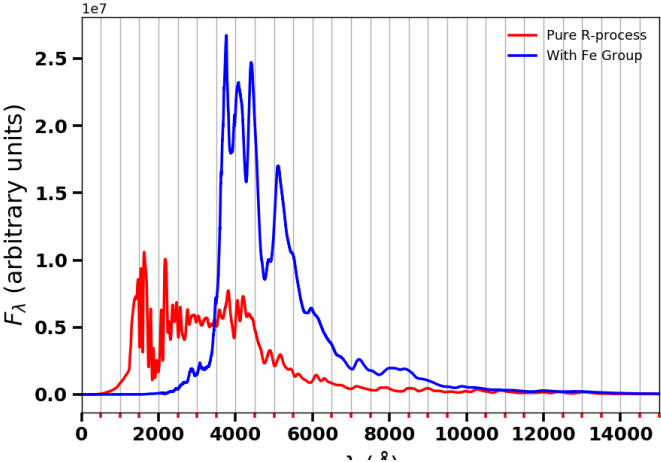
Patrick Vallely

- ▶ Very good undergrad
- ▶ Gone off to OSU to work with Kris Stanek
- ▶ Took “conditions” from Tanaka+16 (Dynamical Ejecta) and Kasen+15 (Disk Wind)
- ▶ 61 NLTE species
- ▶ All Disk Wind Models are Lanthanide poor per Kasen+15

Dynamical Ejecta Model

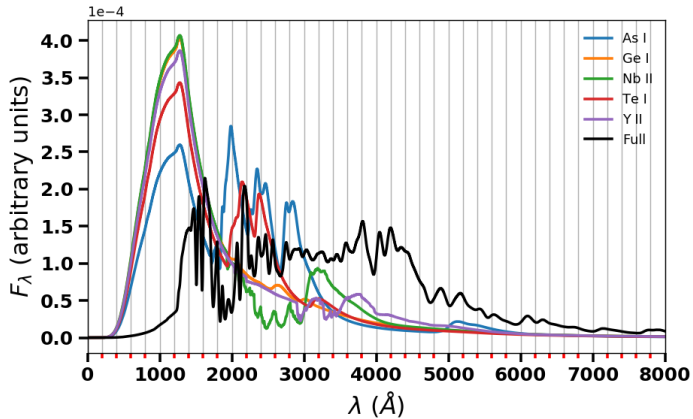


Disk Wind Model



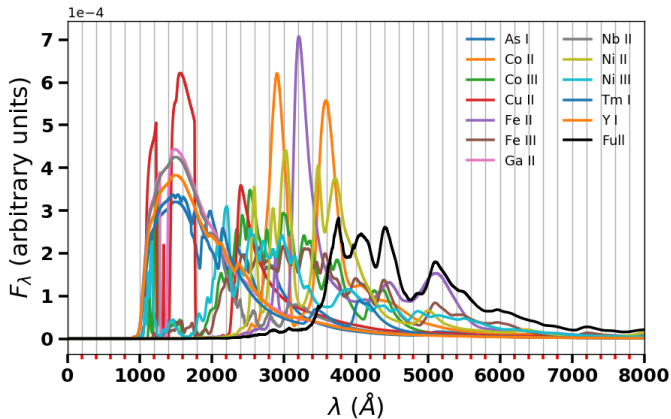
Line IDs

Disk Wind R-process Only

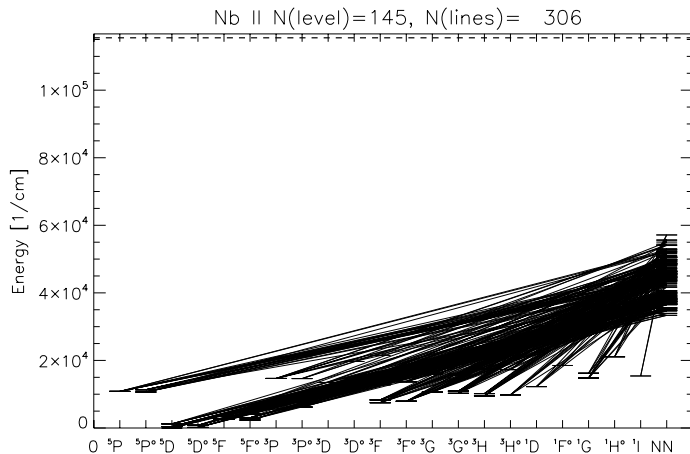


Line IDs I

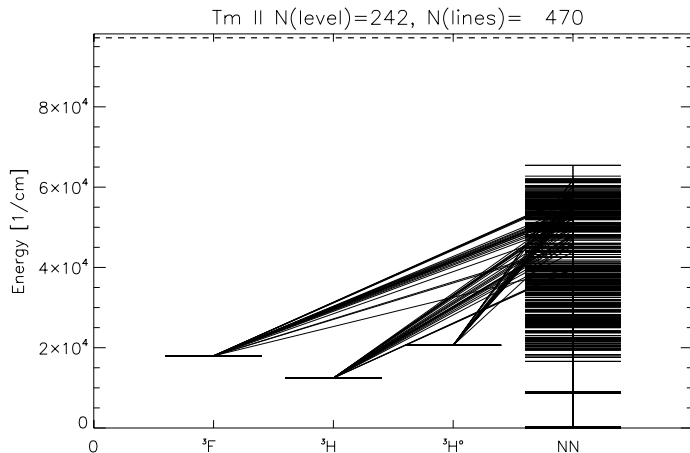
Disk Wind Fe Group + R-process



Model Atoms



Model Atoms



Summary

- ▶ PHOENIX has a role in predictions/analysis
- ▶ Need to explore parameter space more even in simple mode
- ▶ Can't do it alone, need Hydro models from Tanaka+, Kasen+, Metzger+, ...
- ▶ Need improved atomic data, e.g. Fontes+17, Tanaka+17. "Easy" to add
- ▶ Lots of interesting science here:
 - ▶ EM Counterparts for Gravitational Wave detections
 - ▶ R-process site

Metzger, B. D. & Berger, E. 2012, ApJ, 746, 48