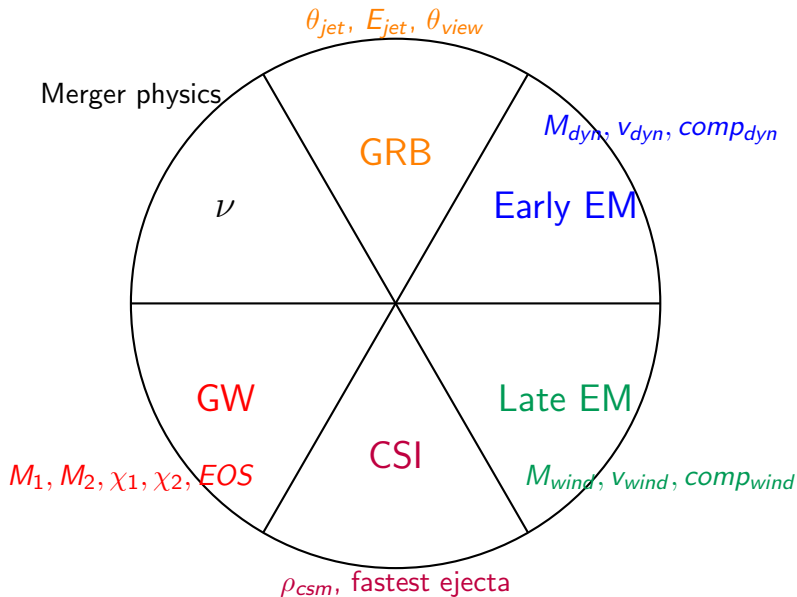


New models for kilonova IR emission - guidance for observation planning

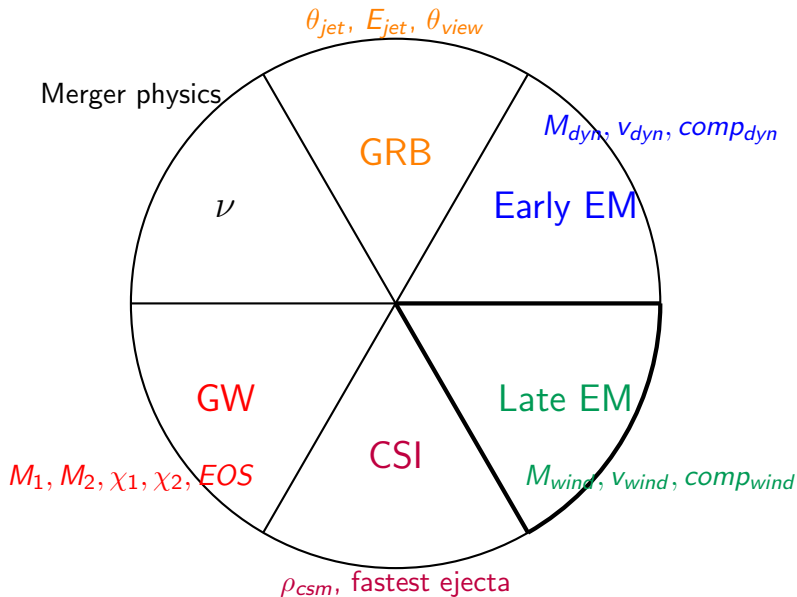
Anders Jerkstrand, with Quentin Pognan, Jon Grumer, Smaranika Banerjee, Eliot Ayache, Blanka Vilagos + many others



The r-process transient Multi-Messenger Cake



The r-process transient Multi-Messenger Cake



Kilonova evolution

Diffusion phase

Optically thick and long escape time for radiation

Spectra probe surface layers

Many lines excited and significant optical depth → scattering spectra



Early tail phase

Optically thick and short escape time for radiation

Spectra probe intermediate layers

Optical/NIR dominates SED. Fluorescence operates.



Late tail phase

Optically thin and short escape time for radiation

Spectra probe inner layers

NIR/MIR dominates SED. Direct abundance probing.



Simple microphysics (LTE), complex transfer

Time →

Complex microphysics (NLTE), simpler transfer

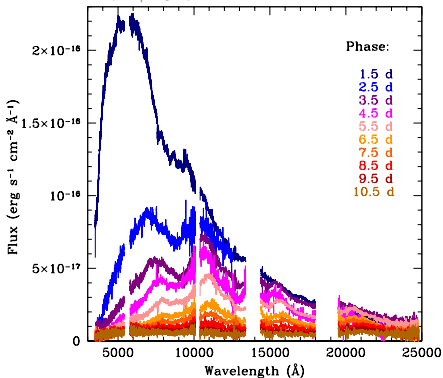
Reviews: Sim 2017, Handbook of SNe

Jerkstrand 2017, Handbook of SNe

Higher Doppler broadening and many active elements and lines \rightarrow transition phases less clear in KNe than in SNe

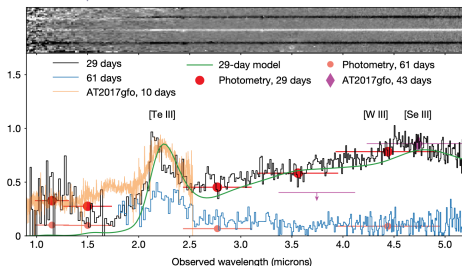
AT2017gfo

Pian+2017



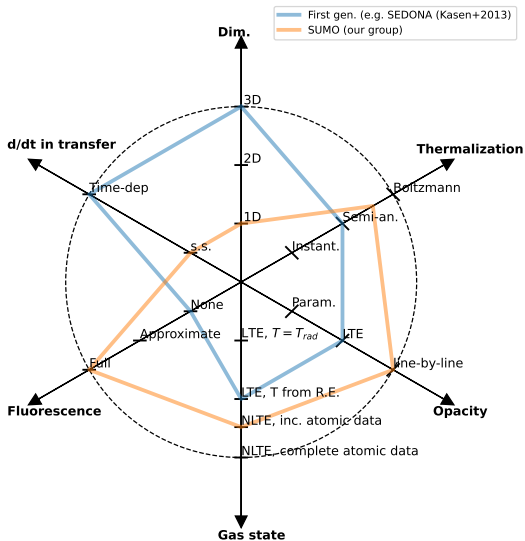
AT2023vfi

Levan+2023

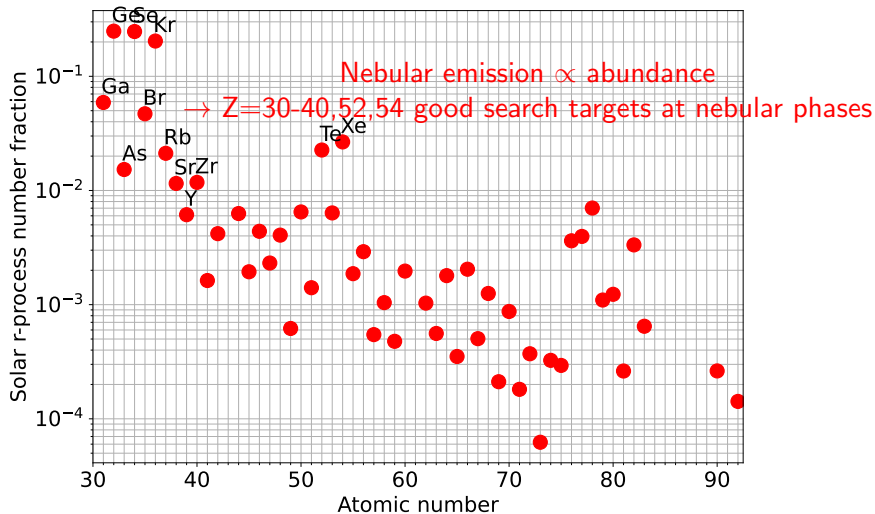


Complex spectral formation \rightarrow interpretation needs guidance from **spectral models**.

KN spectral synthesis modelling



Solar r-process abundances



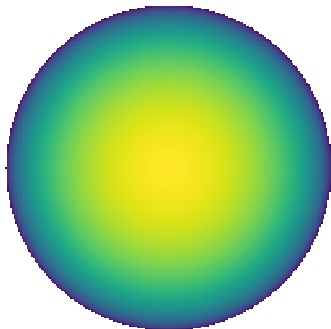
Data from Prantzos+2020

Models exploring the MIR signatures *AJ+ in prep., QP+ in prep.*

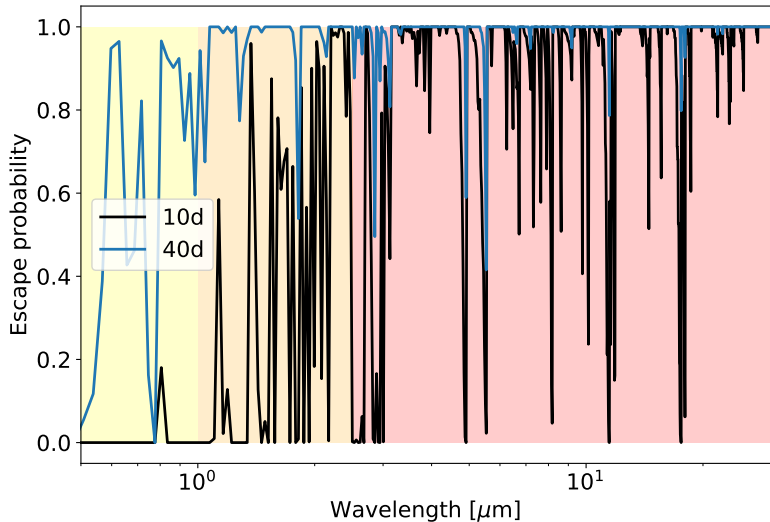
$$M_{\text{ejecta}} = 0.05 M_{\odot}$$

$$\rho(v) \propto v^{-3}$$

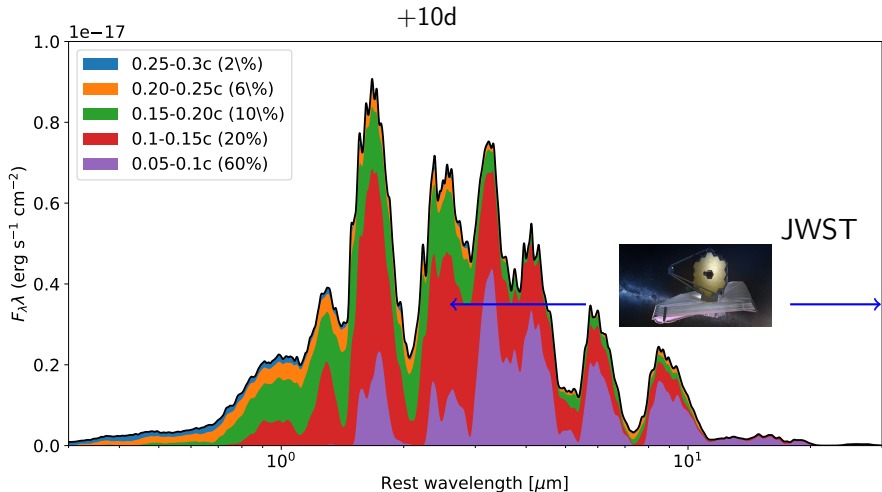
Z=30-40, 52, 54, solar composition.



Transparency vs wavelength



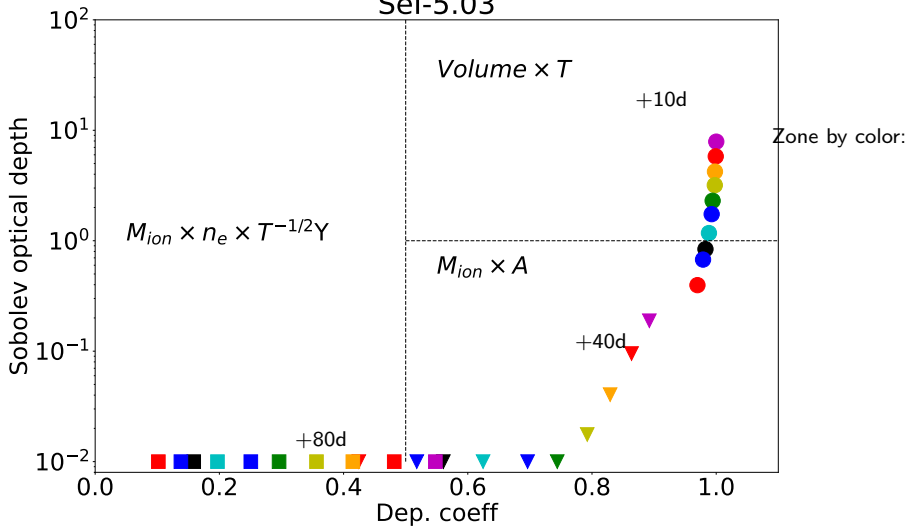
Only long wavelengths probe the main composition



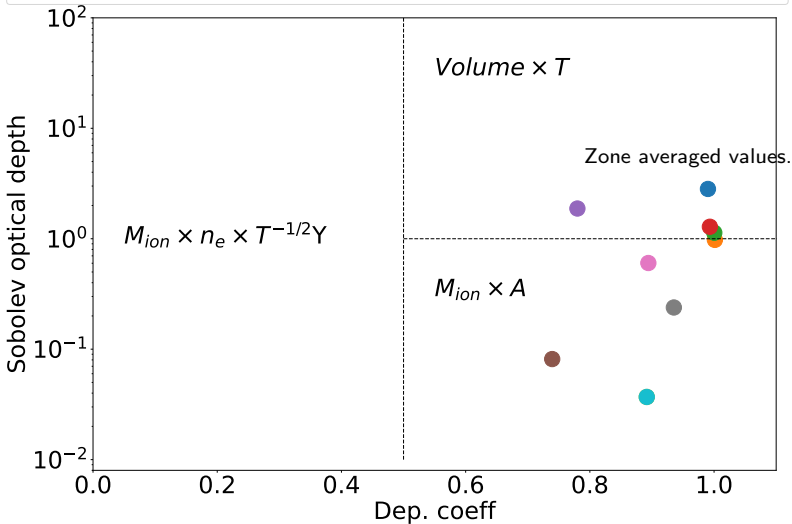
IR emission line domains

AJ 2017, AJ, in prep.

Sel-5.03

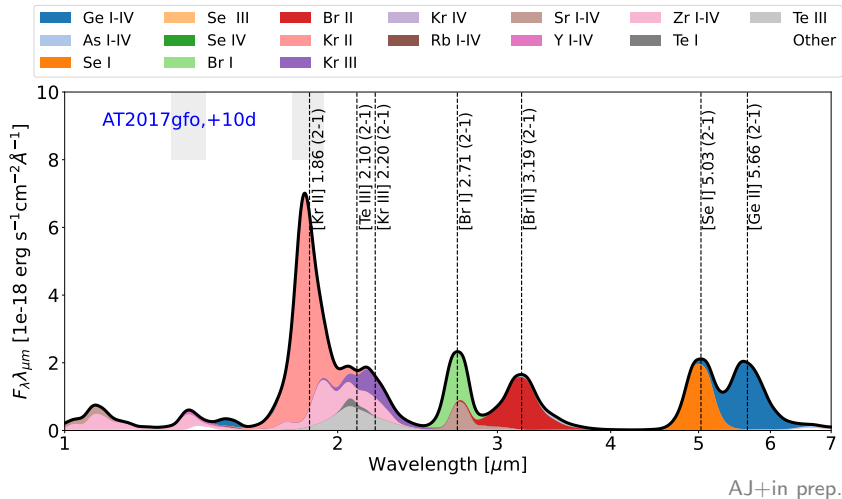


IR emission line domains



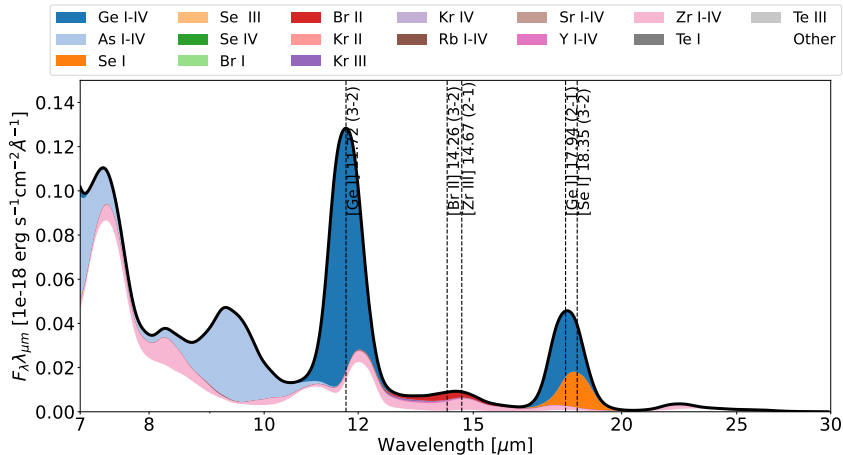
MIR signatures from light r-process elements

An example model at +10d



MIR signatures from light r-process elements

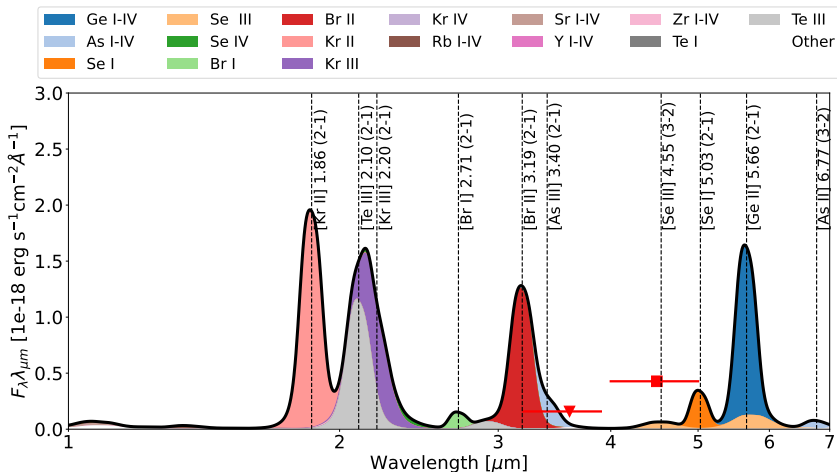
An example model at +10d



AJ+in prep.

MIR signatures from light r-process elements

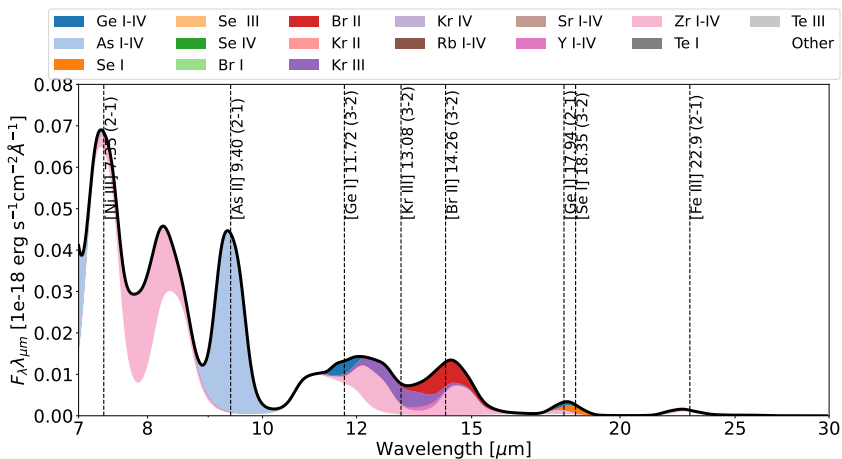
An example model at +40d



AJ+in prep.

MIR signatures from light r-process elements

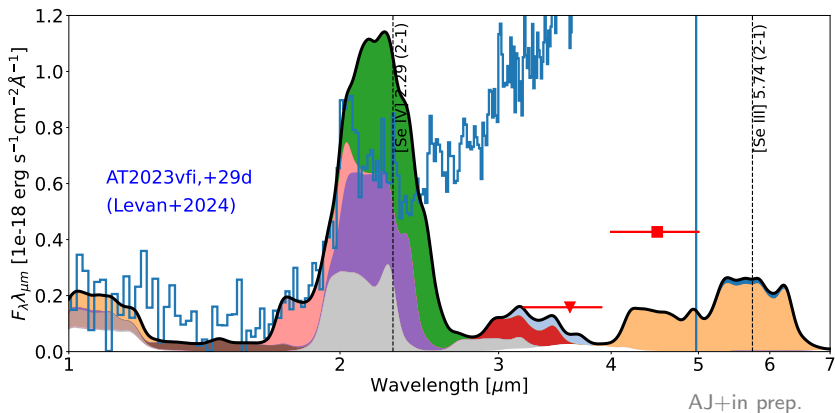
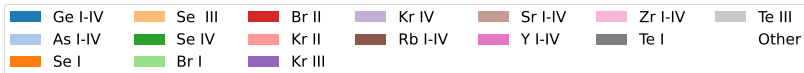
An example model at +40d



AJ+in prep.

MIR signatures from light r-process elements

Another model at +40d



Summary

- **Second generation of KN spectral models** coming into place considering **NLTE** and **fluorescence**. These effects qualitatively change KN spectra from a few days already and are useful for EM follow-up planning and data analysis.
- Tail-phase EM, particular in IR, gives information on **slow/inner material** constituting the **bulk of KN ejecta**.
- **Z=30-40,52,54** are good primary search targets for nebular NIR and MIR lines (AJ+in prep.).