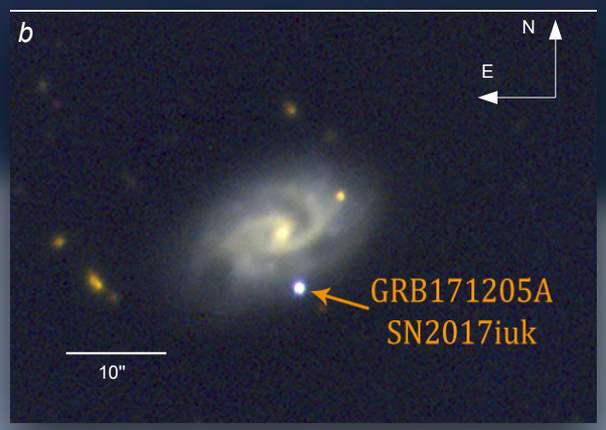
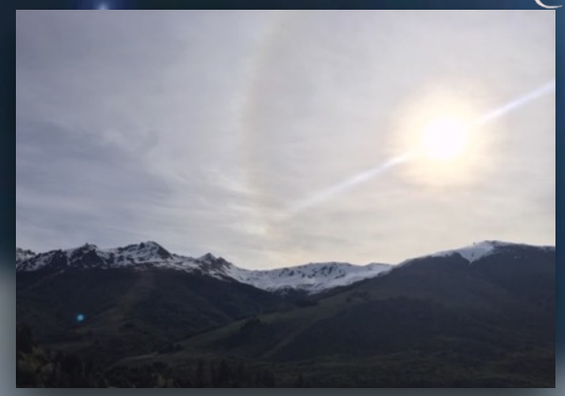
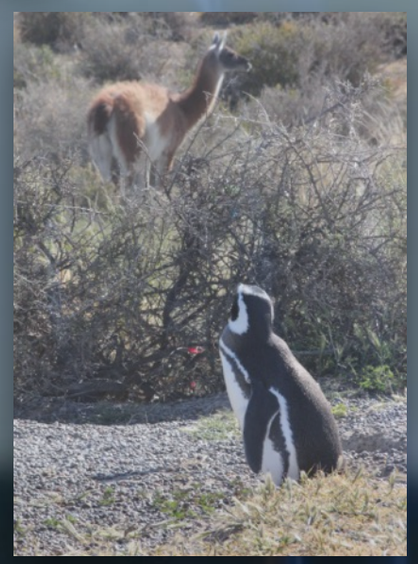
Massive stars & SNe, Bariloche, Nov. 8 2018





GRB 171205A
cocoon signatures in an early GRB-SN
hosted by a grand-design spiral

Christina Thöne (IAA-CSIC/HETH)
on behalf of Luca Izzo (IAA/HETH)

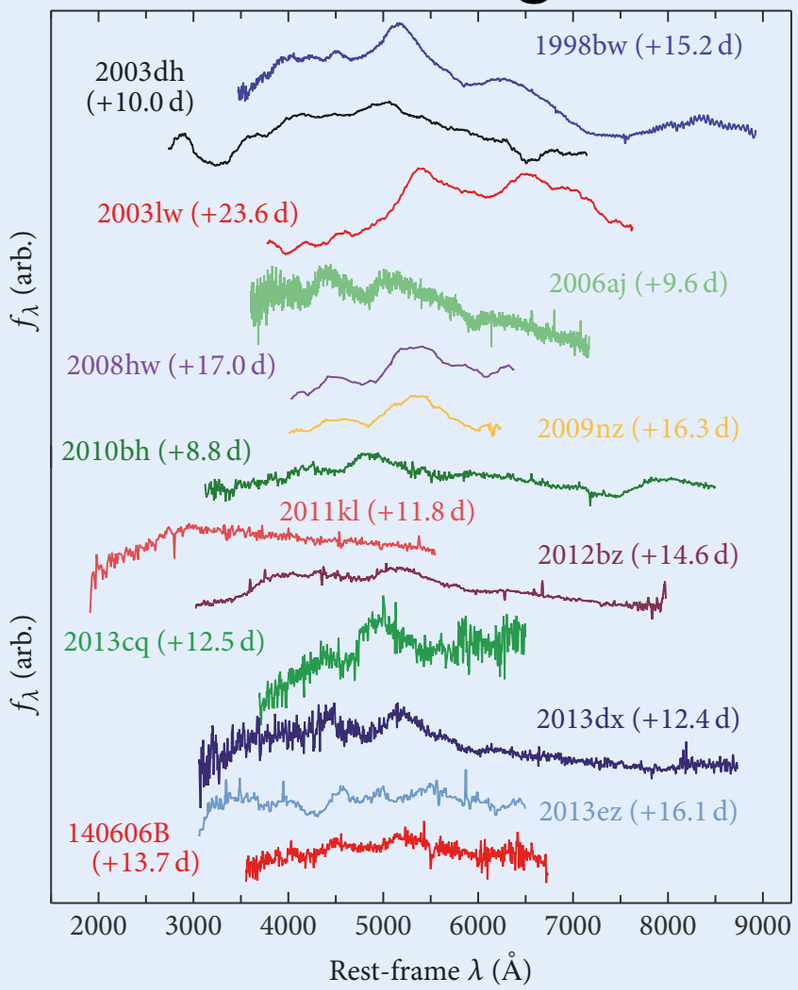


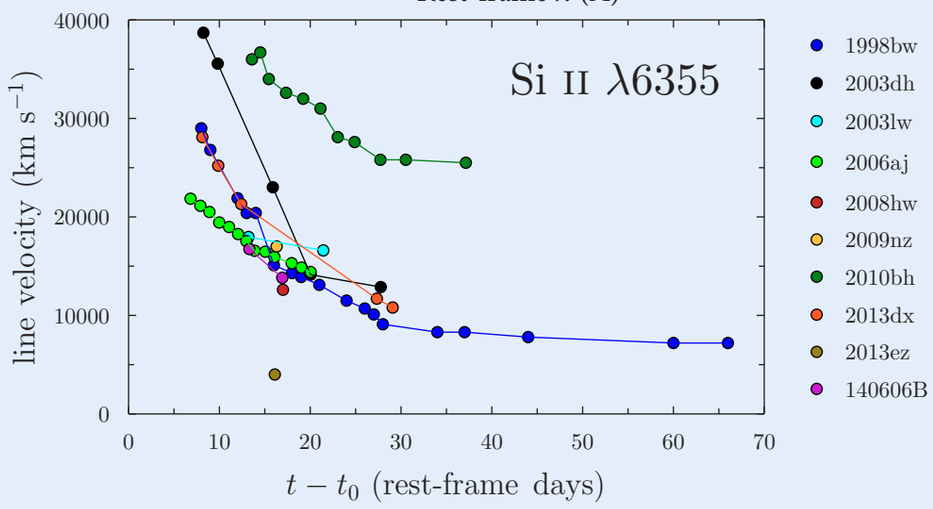
based on: L. Izzo, A. de Ugarte Postigo, K. Maeda, C. C. Thöne, D.A. Kann et al., Nature in press
and: Thöne et al. in prep & de Ugarte Postigo et al. in prep.

Cano et al. 2016, de Ugarte et al. 2018

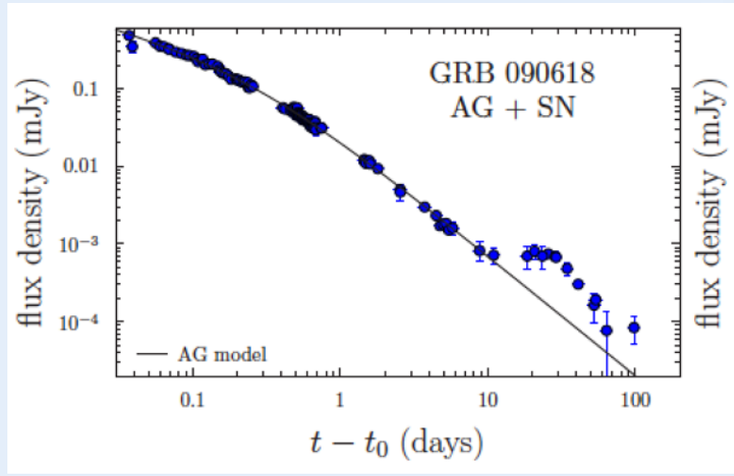
Long GRBs & BL-Ic SNe

Broad lines = high velocities

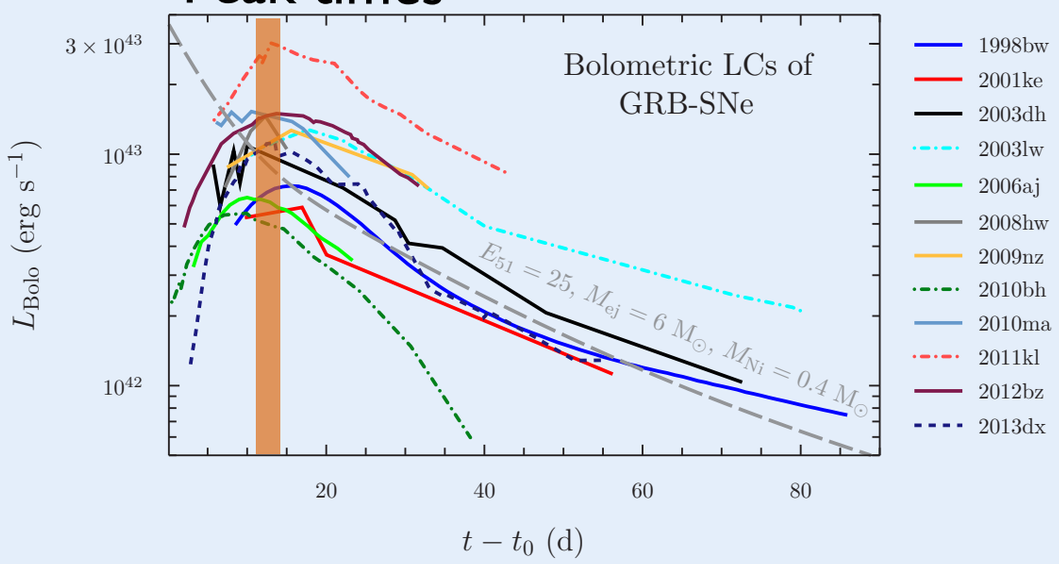




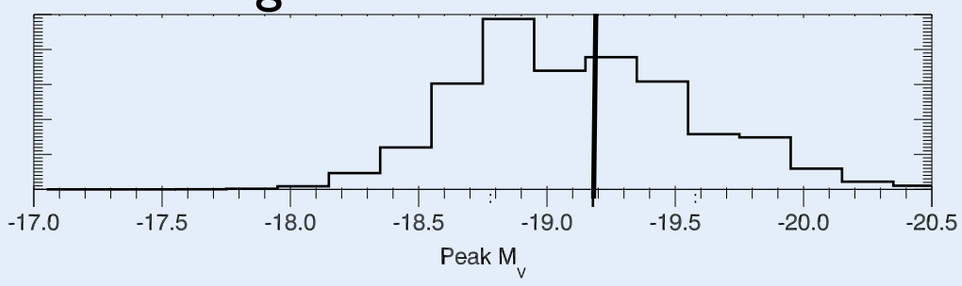
afterglow (powerlaw) → SN (BB) → host (galaxy)



Peak times

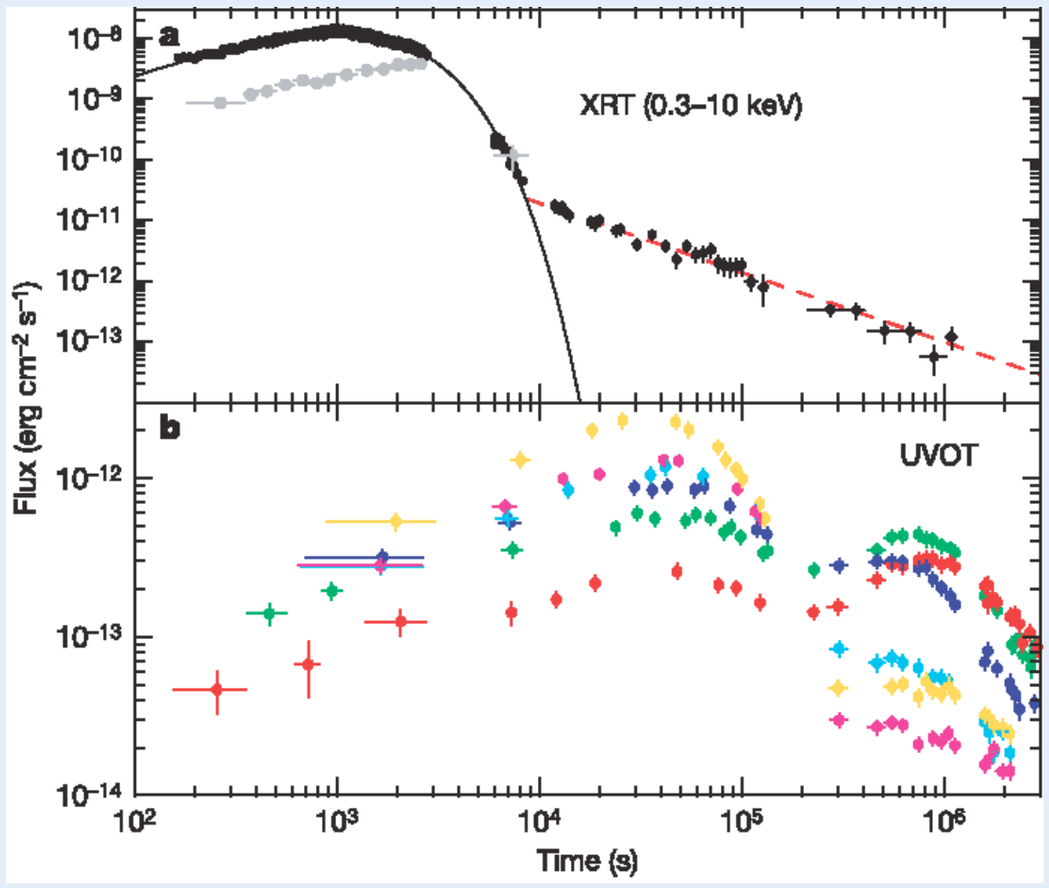


Peak mags

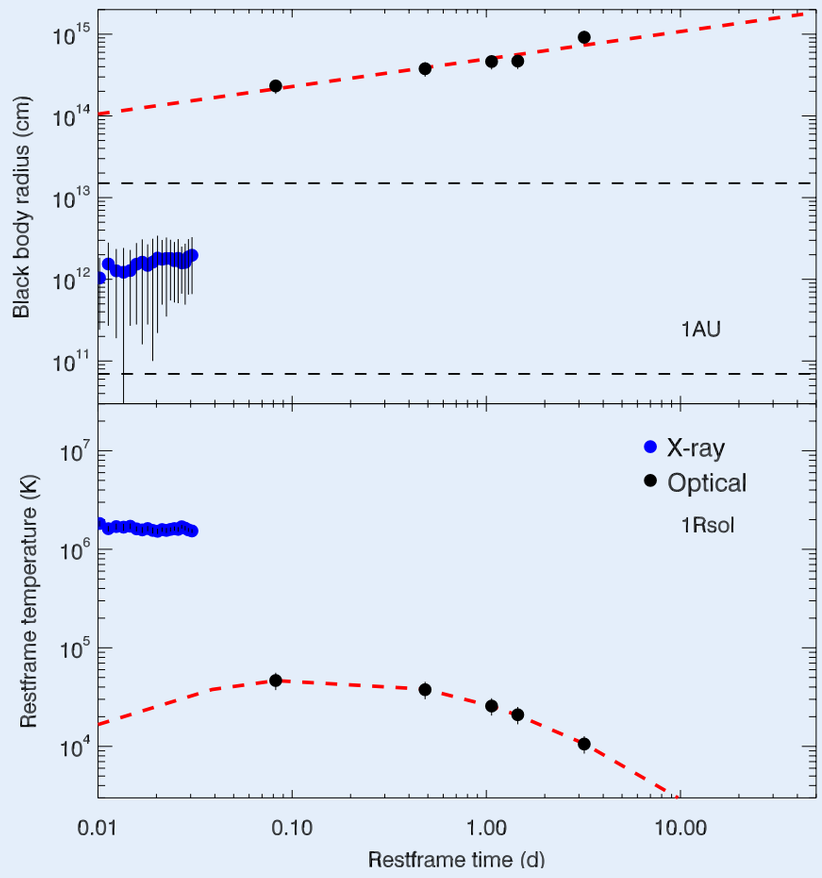


Early components in GRB-SNe

- X-ray black-body components in GRBs (e.g. Starling et al. 2012, Friis et al. 2013)
- The curious cases of GRB 060218 and GRB101225A (the „Christmas burst“) →no early spectra!



Campana et al. 2006



Thöne et al. 2011

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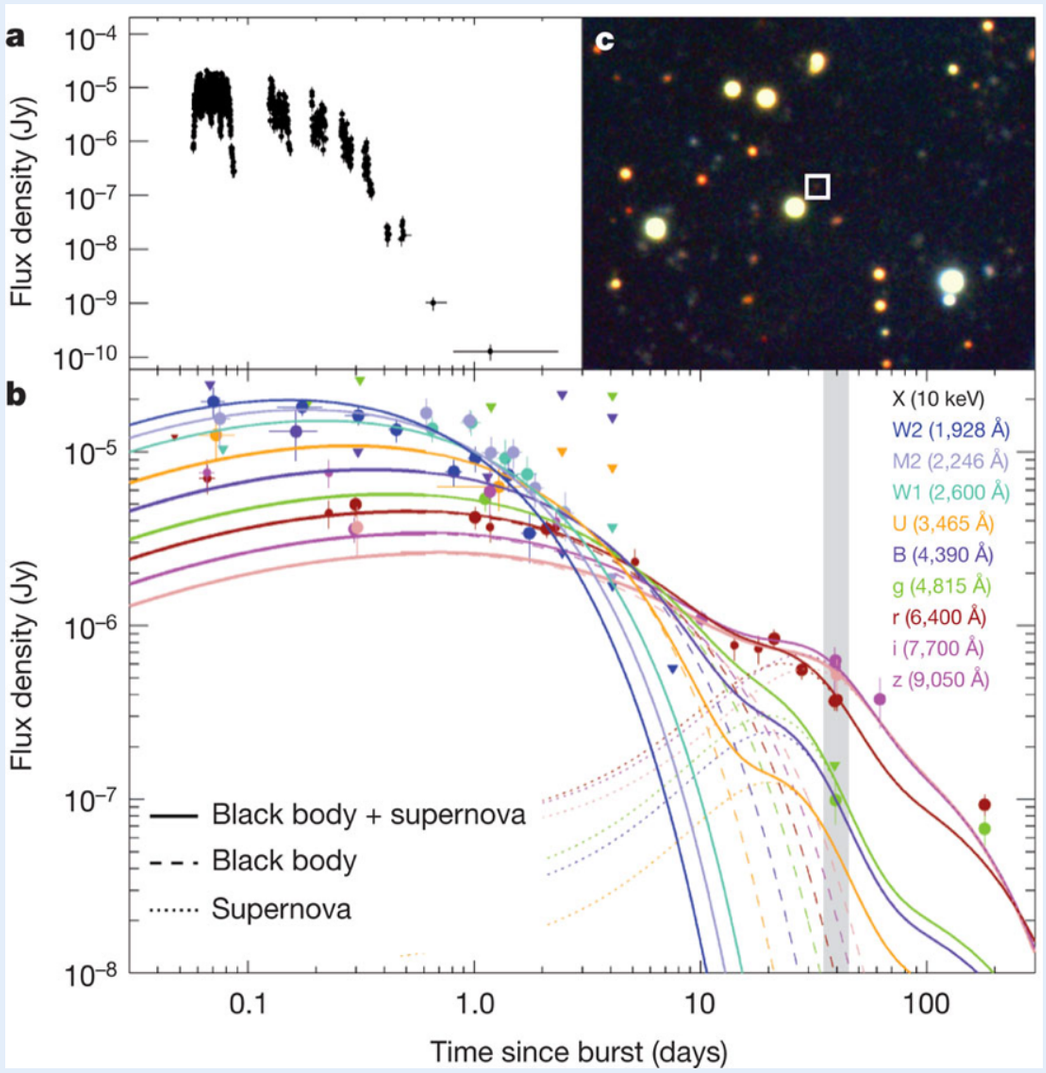
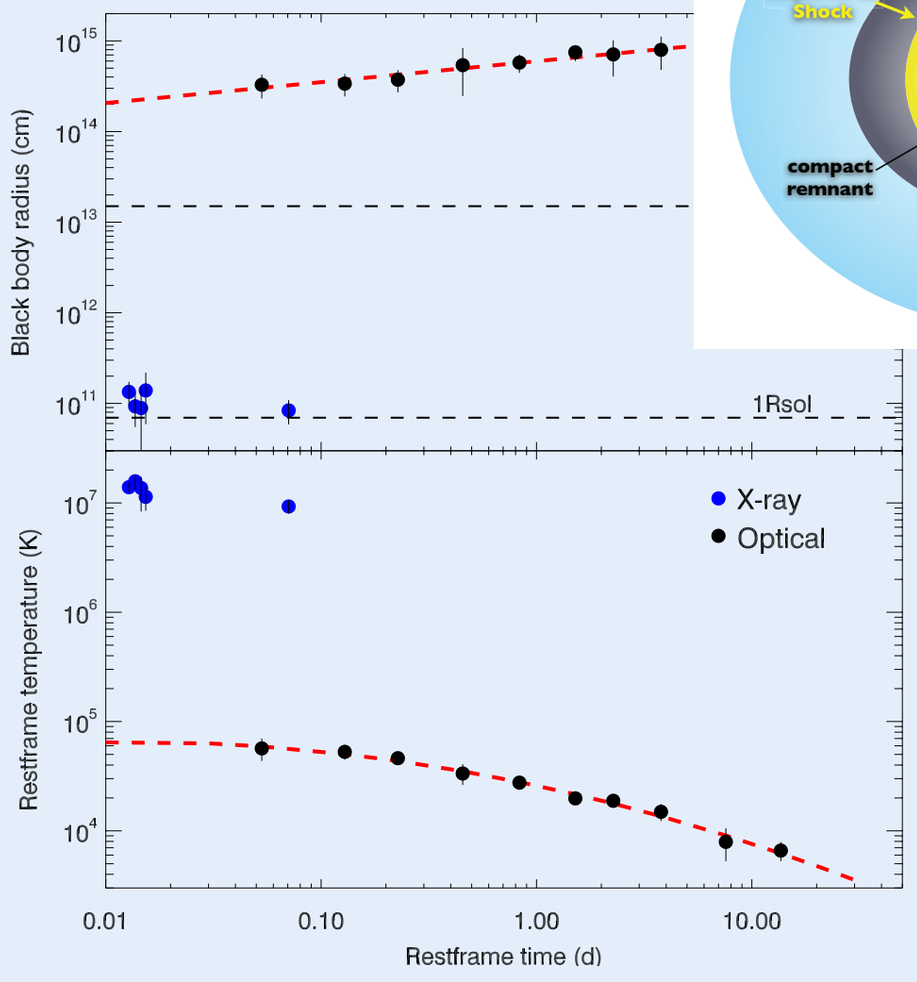
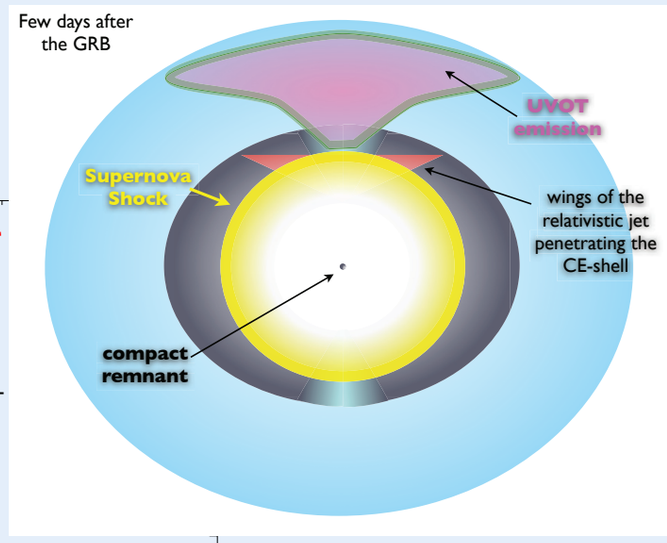


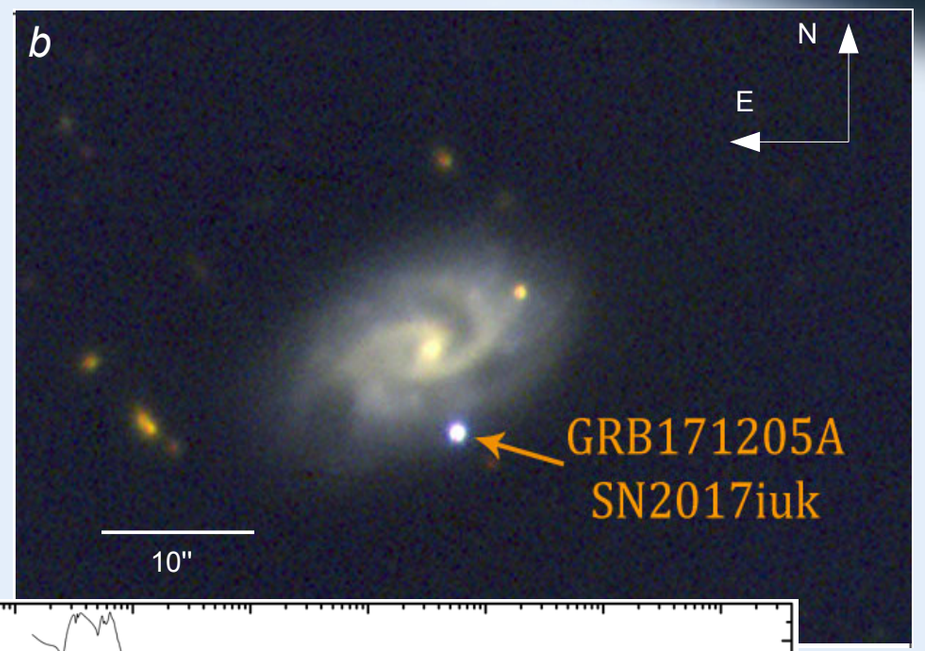


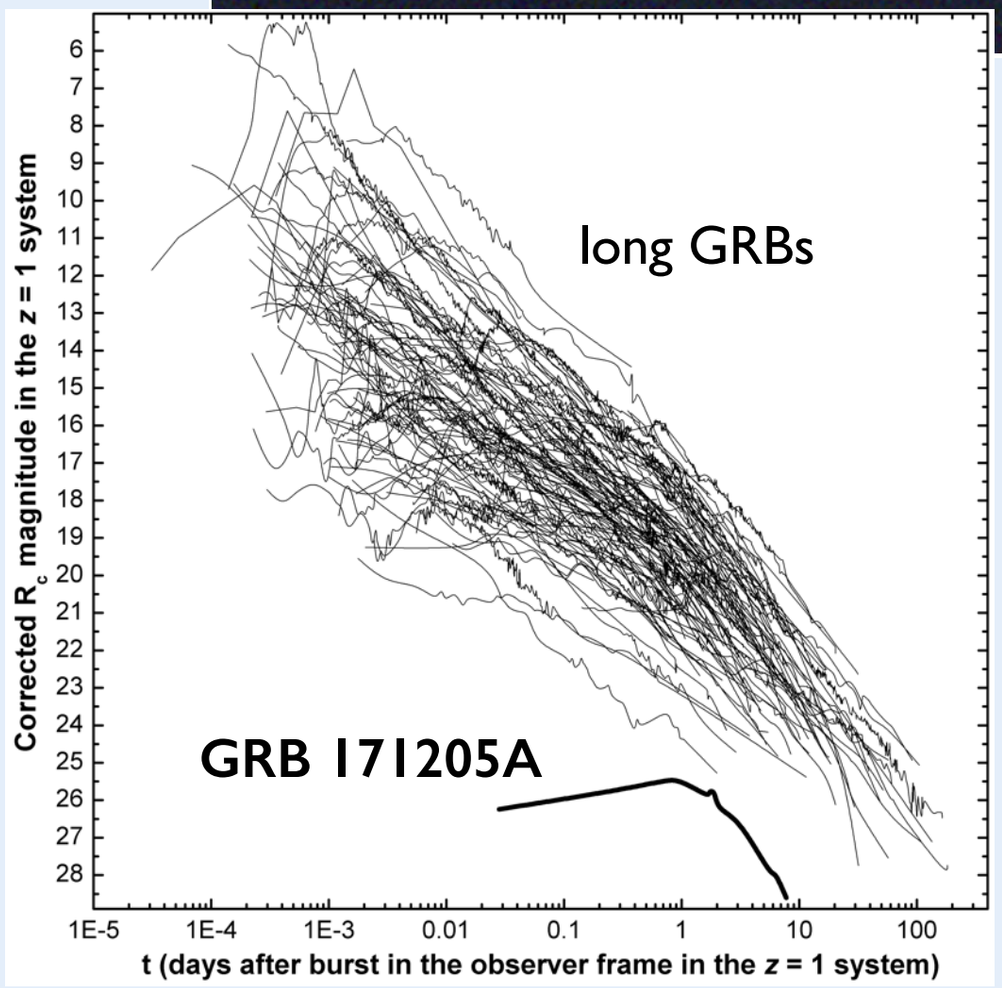


Thöne et al. 2011

GRB 171205A

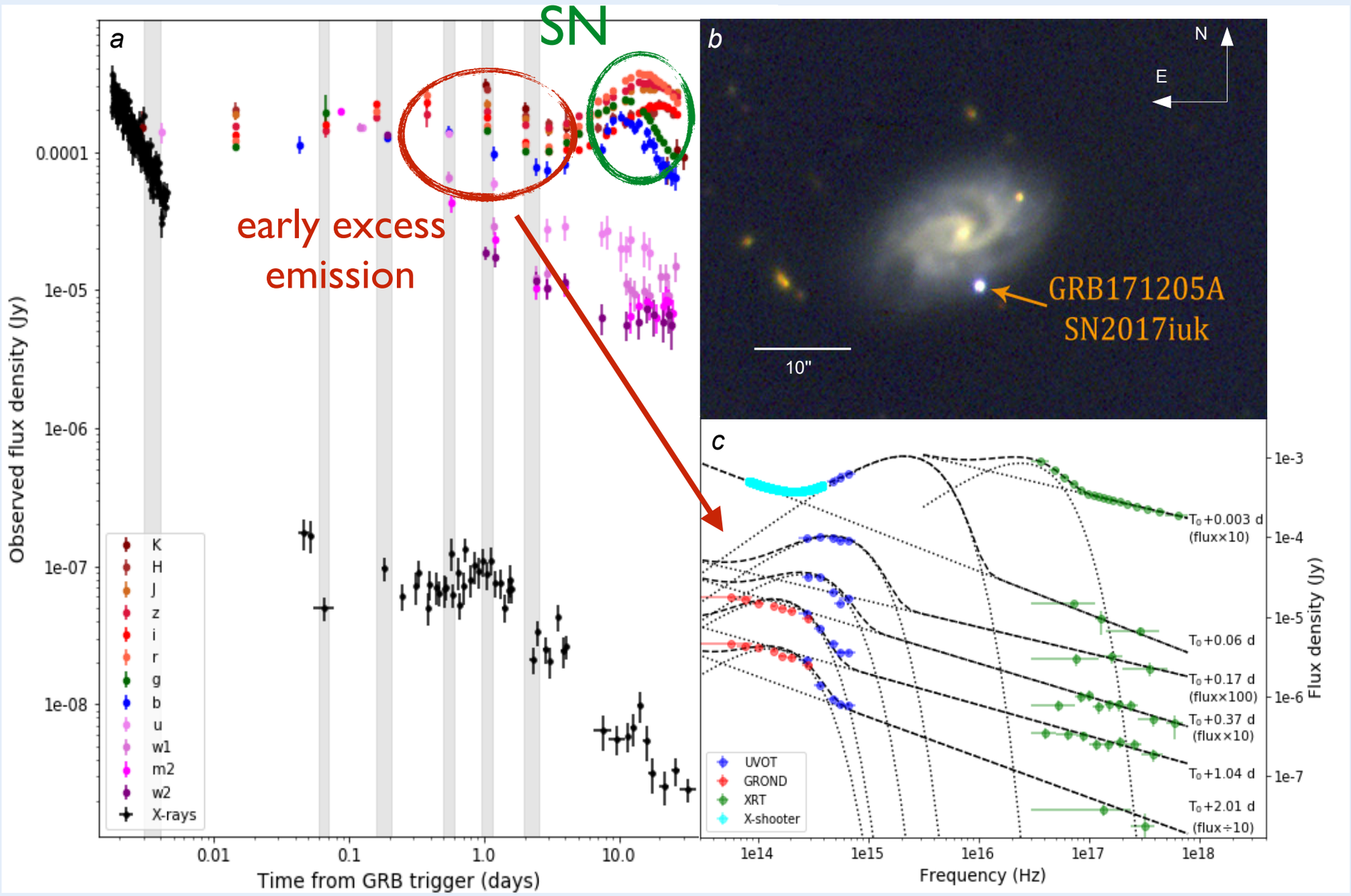
- T_{90}=190s
- D=163 Mpc (*3rd closest*)
- low-luminosity GRB ($L_{iso}=3\times10^{47}$ erg/s) very faint afterglow
- M_V(SN)=-18.4 mag (*second faintest GRB-SN*)
- Massive host (log M=10.1 $M_\odot$), grand-design spiral galaxy (*first time for a low-z GRB!*)
- Extensive spectral follow-up campaign with GTC + X-shooter (0d to 180d post GRB)





An unusual light curve

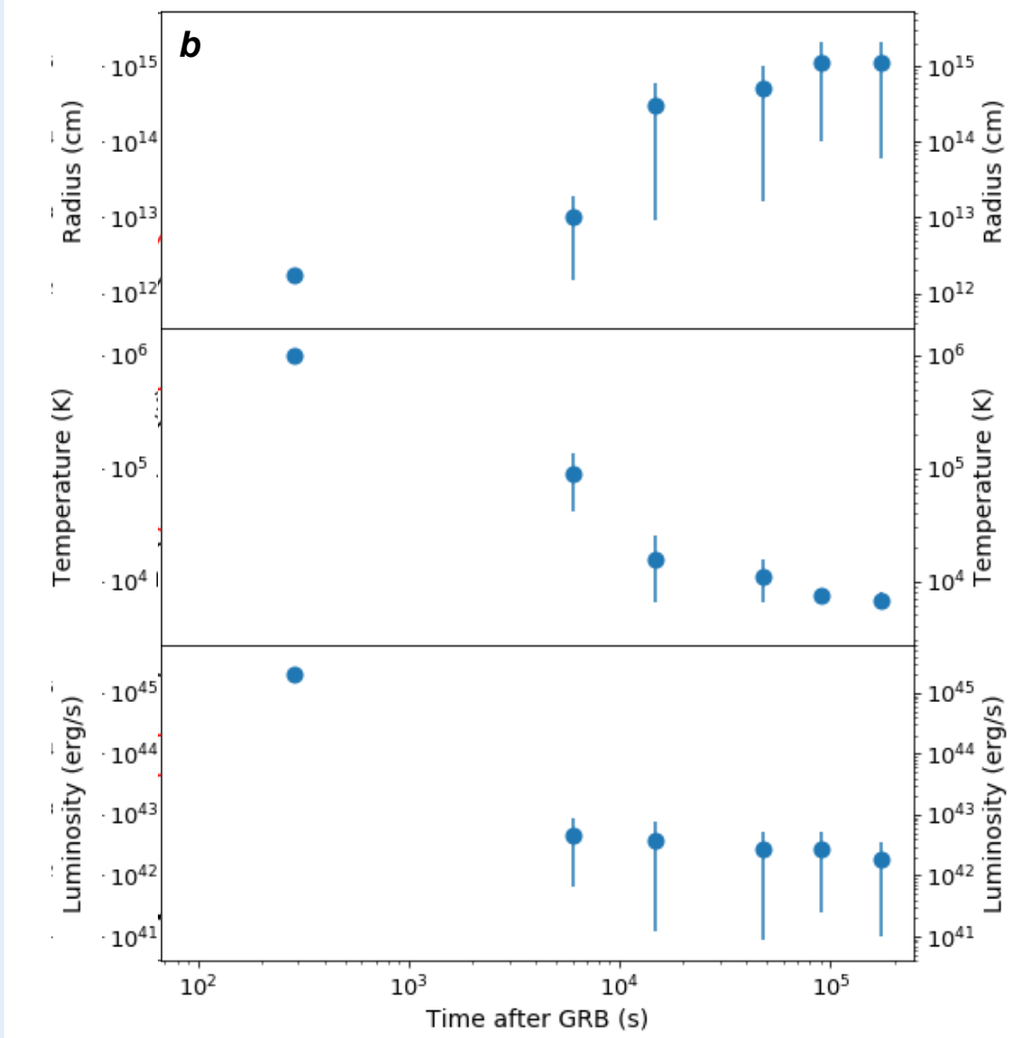
- Early bump in light curve

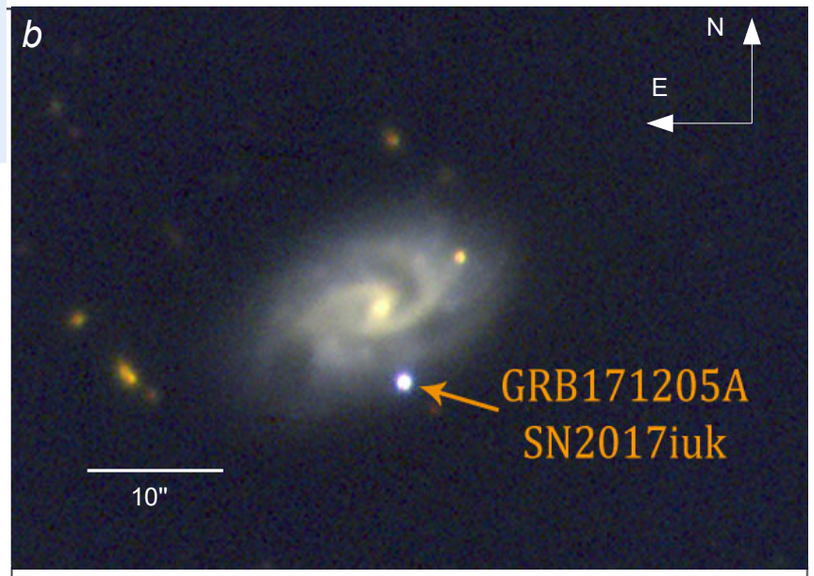


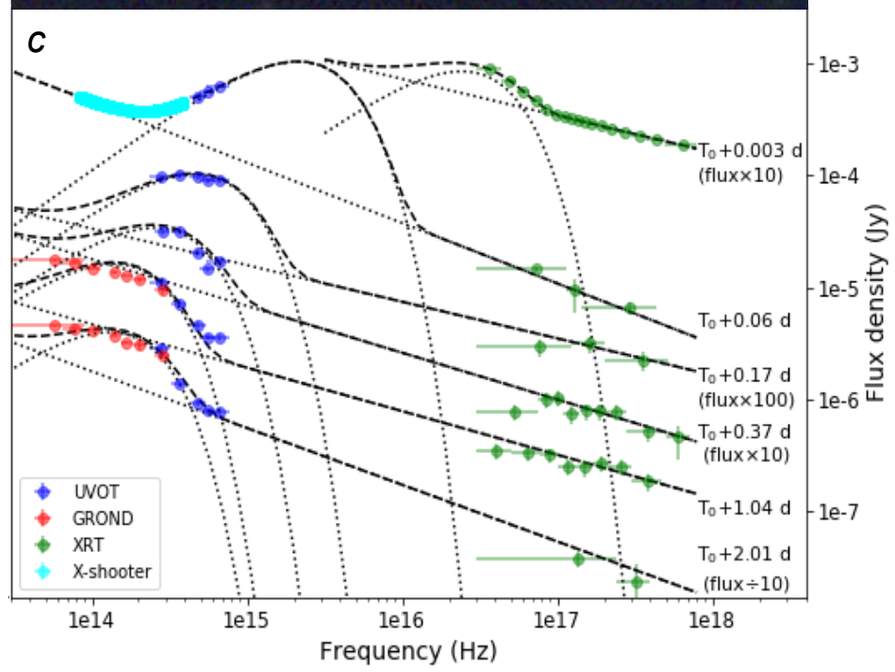
An early BB emission

- Early bump in light curve, consistent with evolving BB starting in X-rays

BB evolution

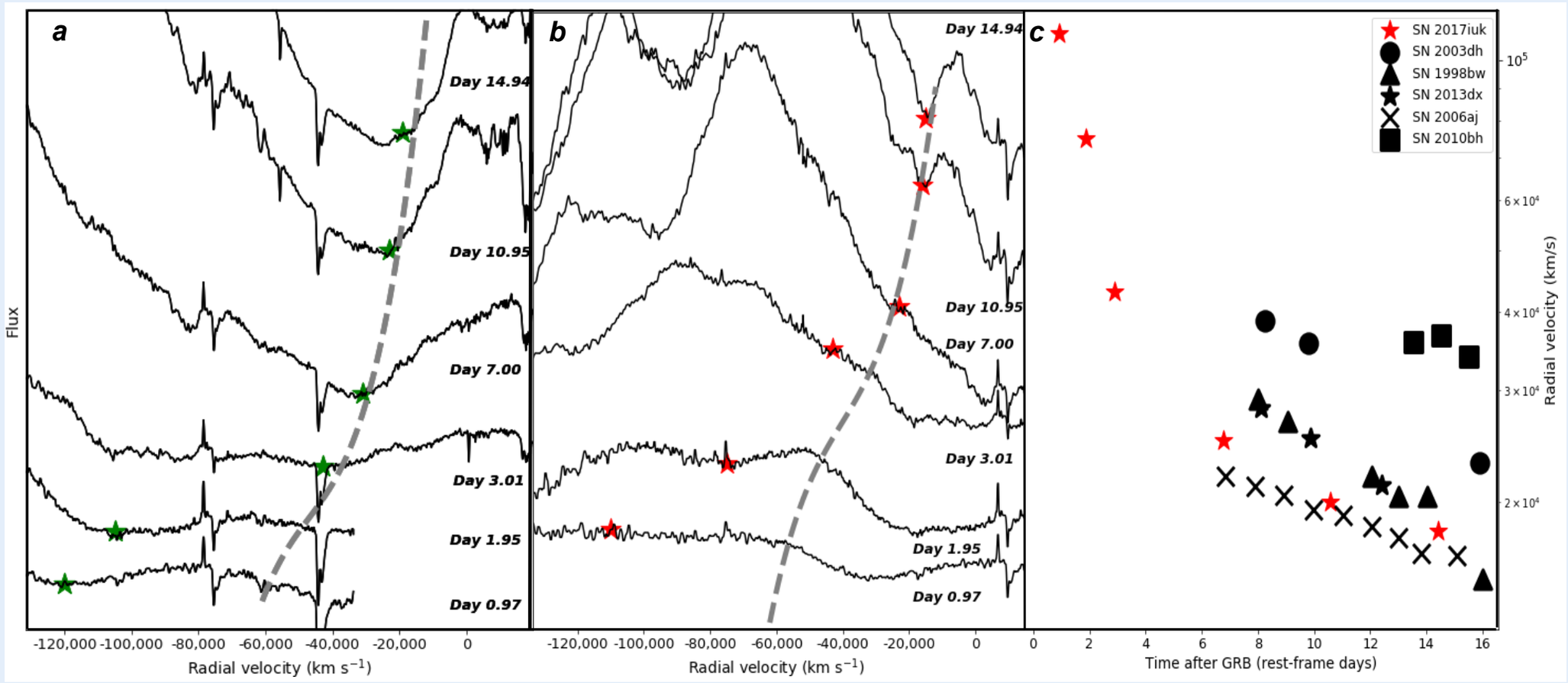






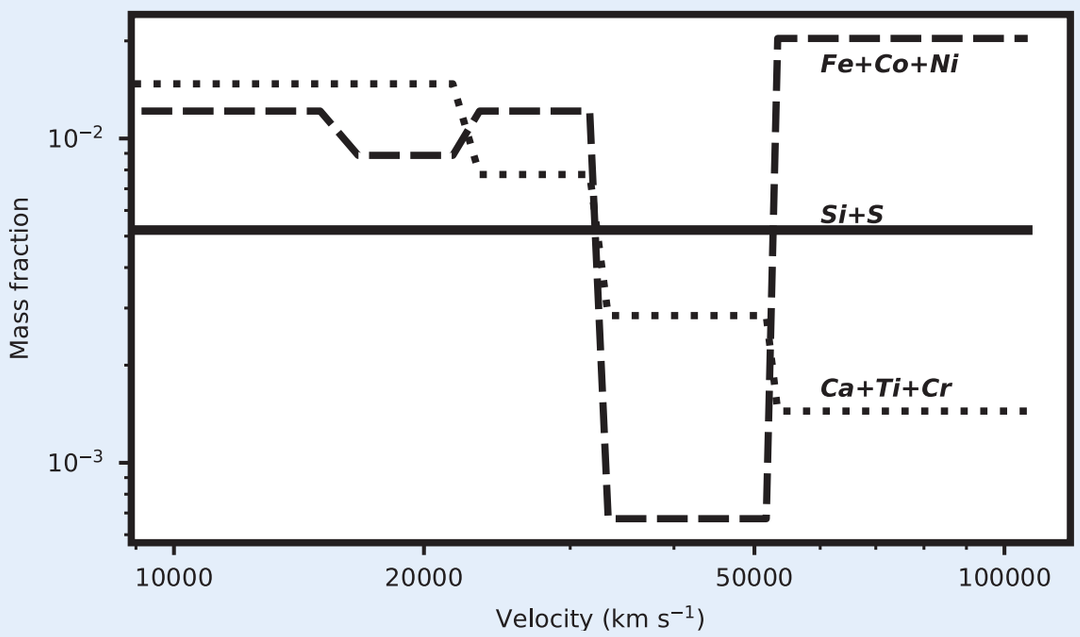
Extreme early velocity features

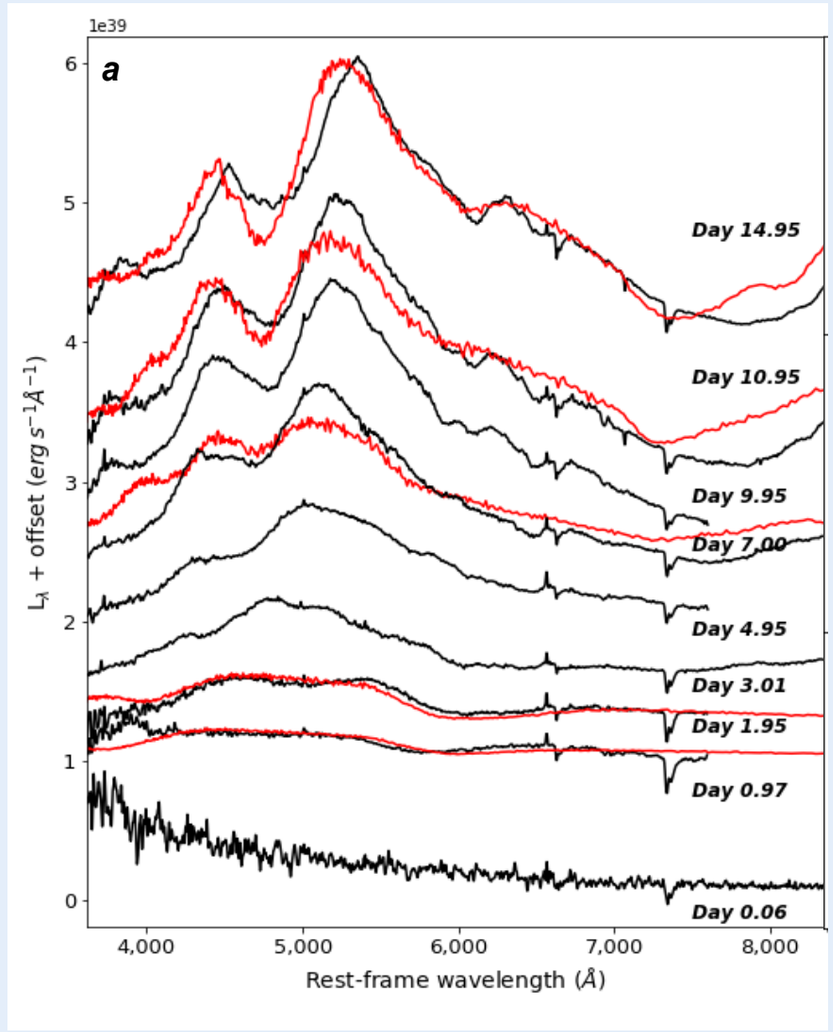
- First X-shooter spectrum at 1.5h, additional continuum emission visible
- Very broad SN features in spectra at 0.9d
  v~115,000 km/s, FWHM ~35,000 km/s
  (based on CaII triplet and SiII 6355, maybe also FeII)



Modeling the spectral evolution

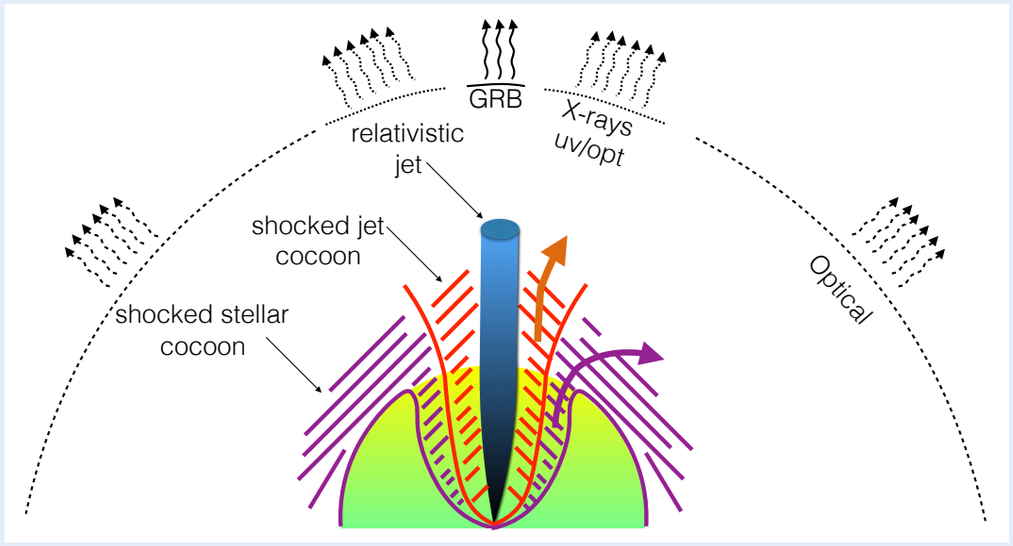
- Spectral synthesis modeling with TARDIS, model CO138 (K. Maeda)
- Two component model: early/outer/fast - late/inner/slower component
- Fast comp. has „inverted“ composition from expelled core material
- M_{ej}: cocoon > 55,000 km/s: 0.13 $M_\odot$ (0.001 $M_\odot$ above 100,000 km/s)
  total: 4.9 $M_\odot$, 0.18 $M_\odot$ ^{56}Ni
  E_{kin} = 2.4x10^{52} erg
- Complete SN modeling needed
  (Kann et al. in prep.)





What do we observe?

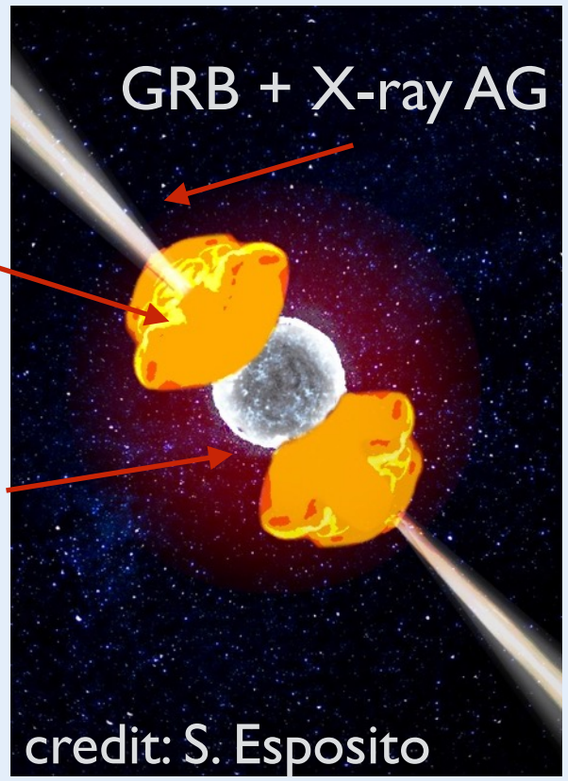
- First clear evidence of a cocoon from the jet-star interaction (e.g. Nakar et al. 2016), now very fashion in NS-NS merger models
- Jet breaks out of star → Fe-peak rich material transported outwards, high velocities, early hot BB emission → weak afterglow (X-rays) → BL-Ic SN
- Low-Luminosity GRBs = „normal“ GRBs with stronger jet interaction? Explanation for other early BB emissions (e.g. GRB 060218)? And/or different progenitors for ultra-long GRBs?? (Needs more study, Kann et al. in prep.)



Nakar & Piran 2016

high-v material
early bump

SN

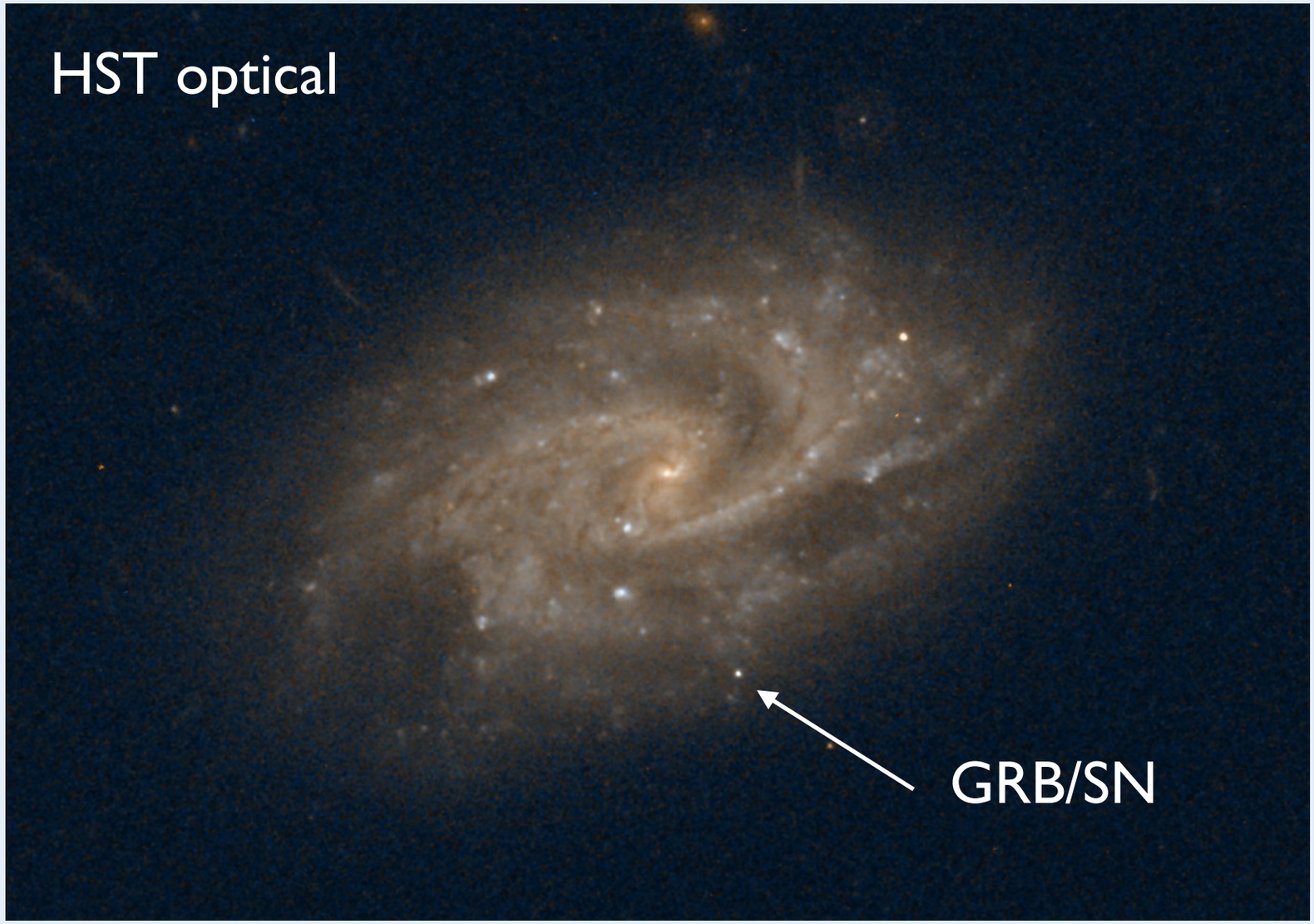


Thöne et al. in prep.

The host

1h MUSE

barred spiral host with GRB in HII region in the outskirts



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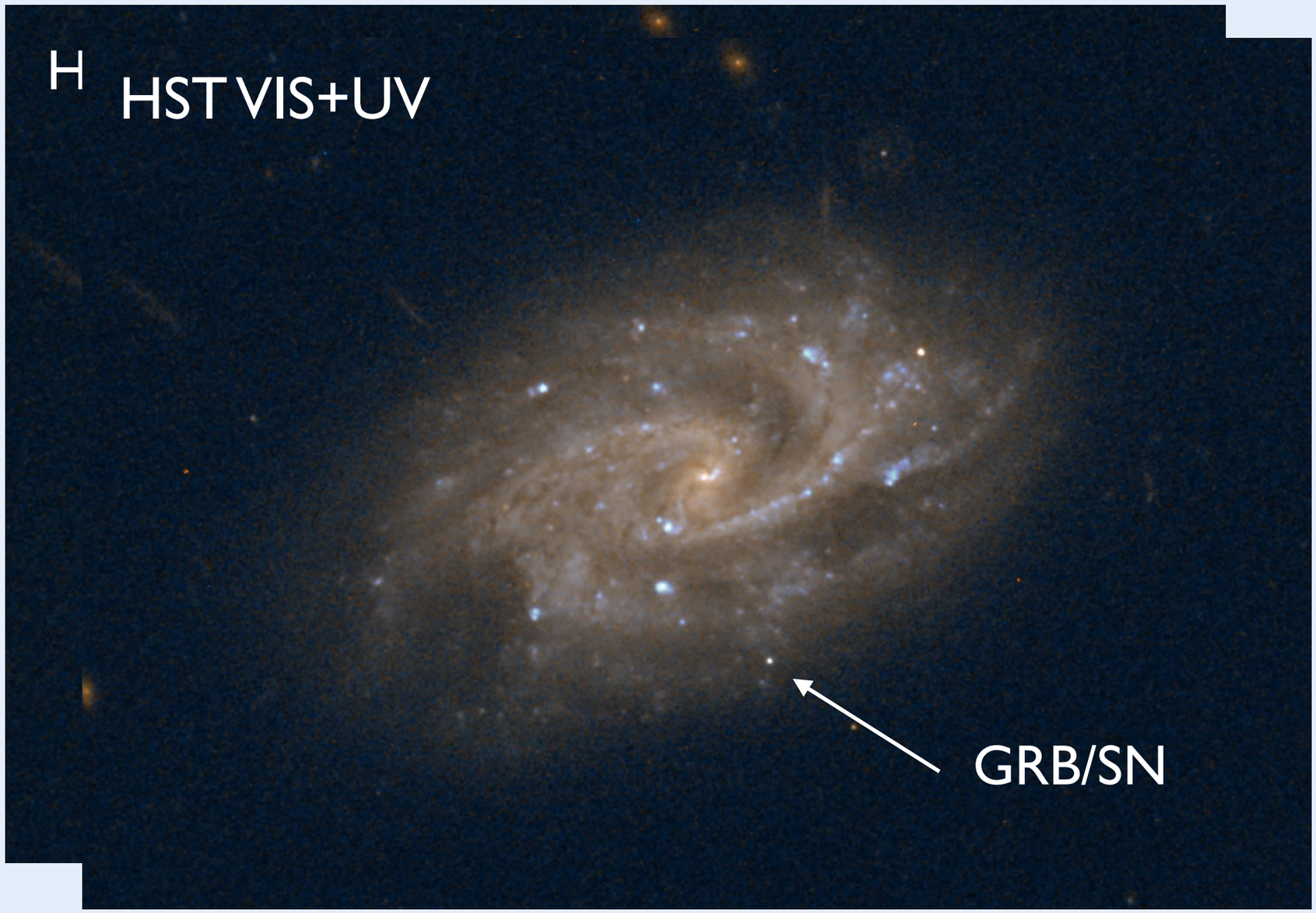

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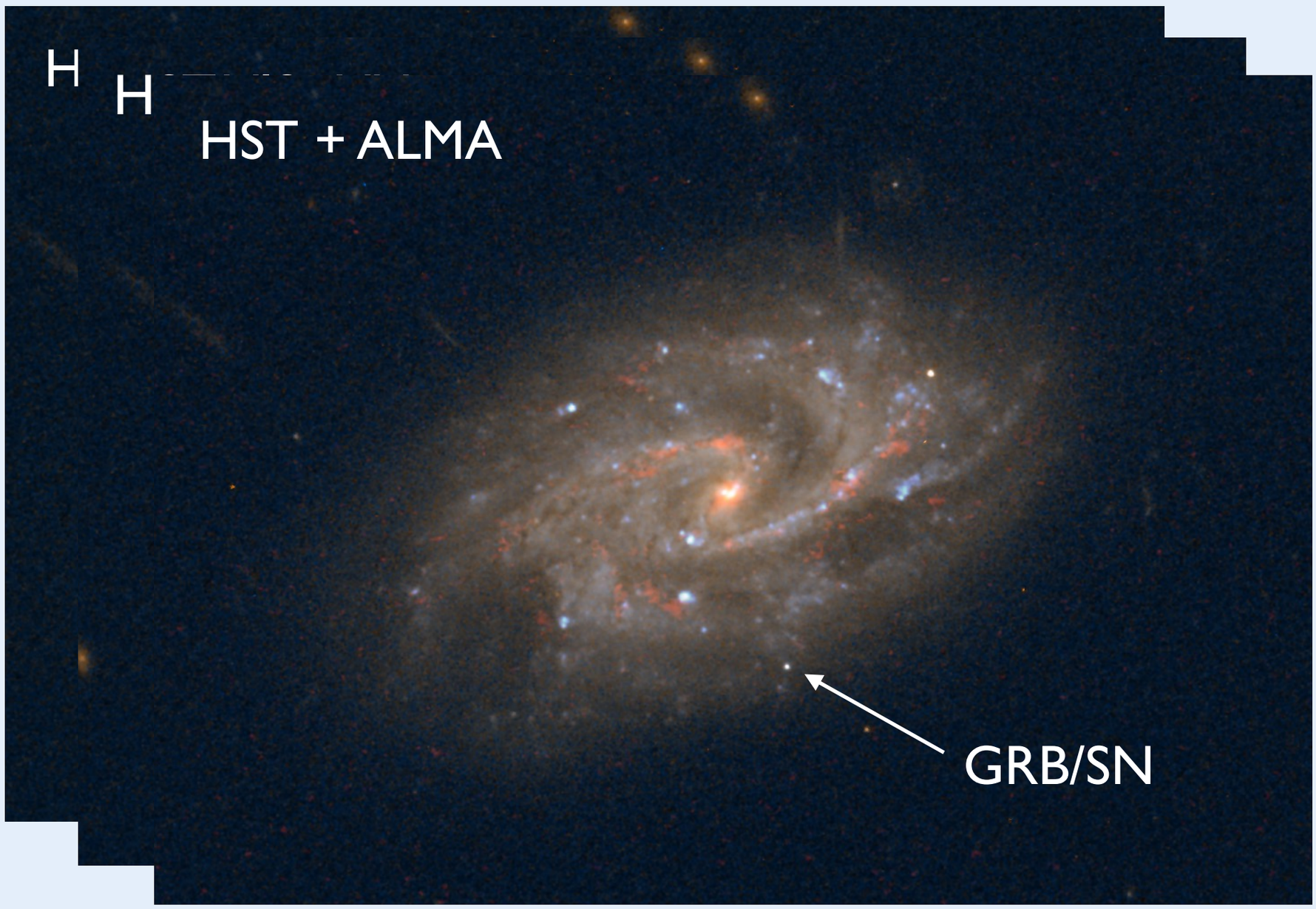
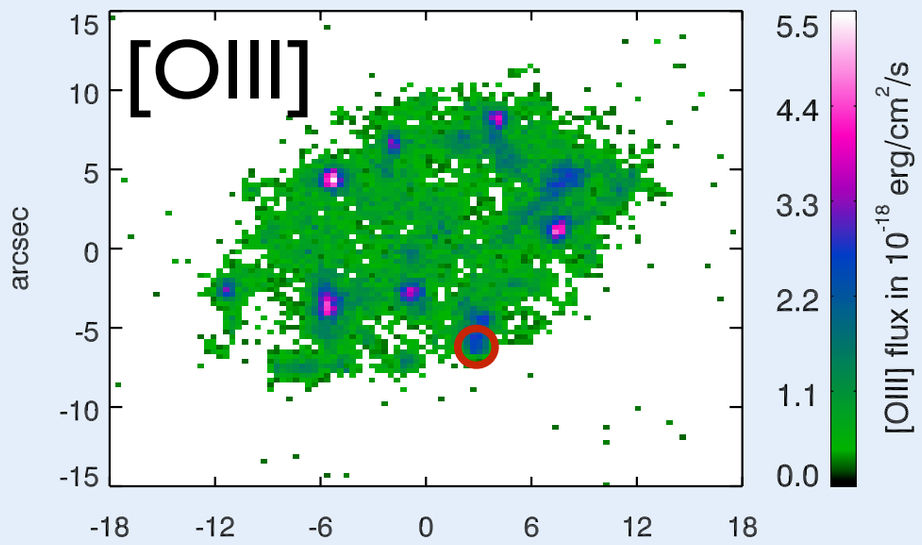
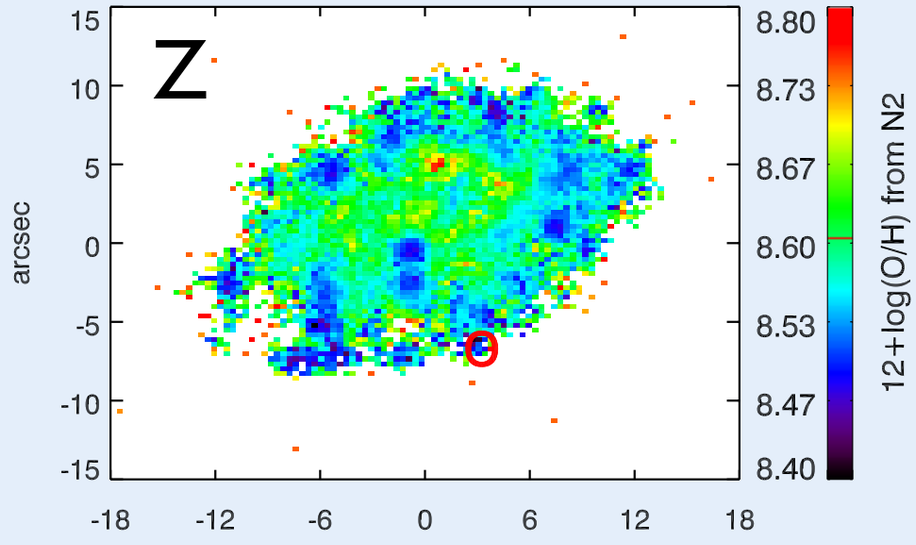
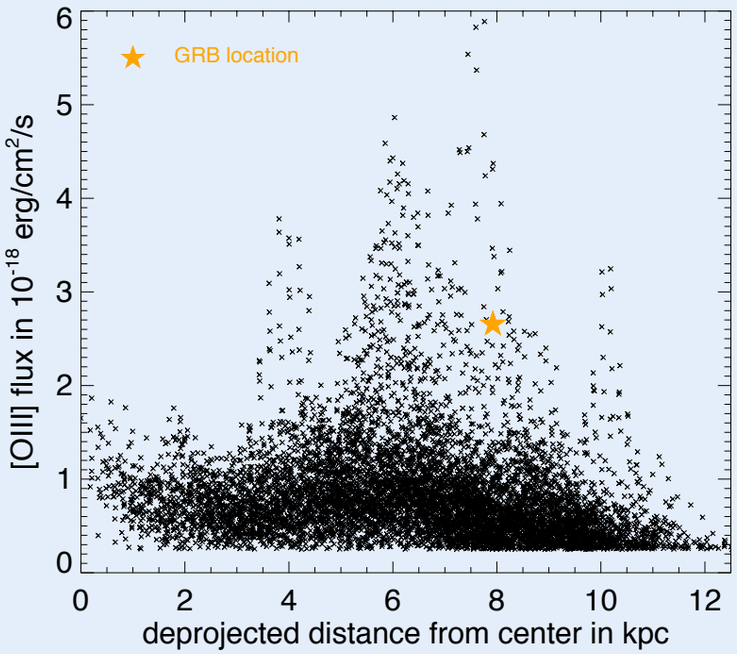


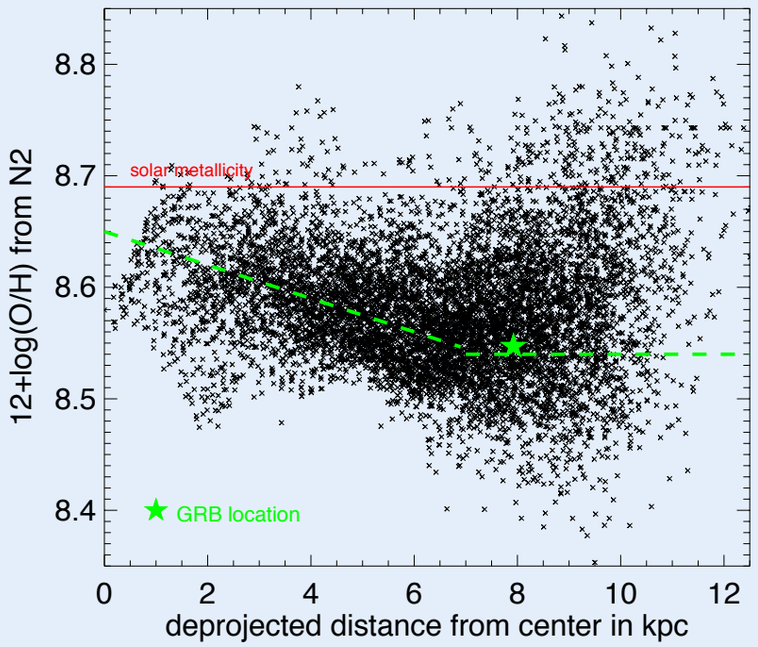
The host

- Barred spiral, GRB in HII region in spiral arm
- star-forming „ring of pearls“
- high ionization region, 12+log(O/H)~8.45, shallow Z-gradient





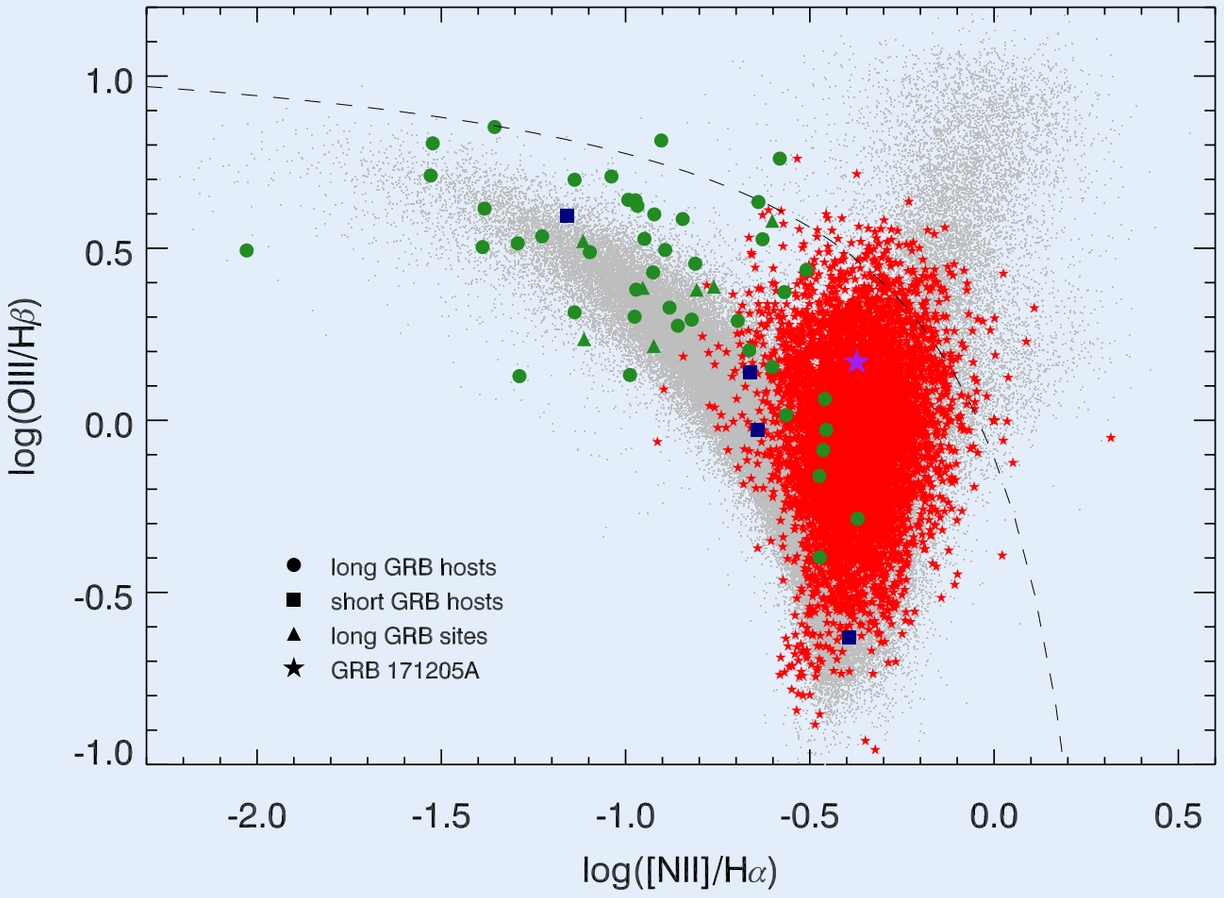


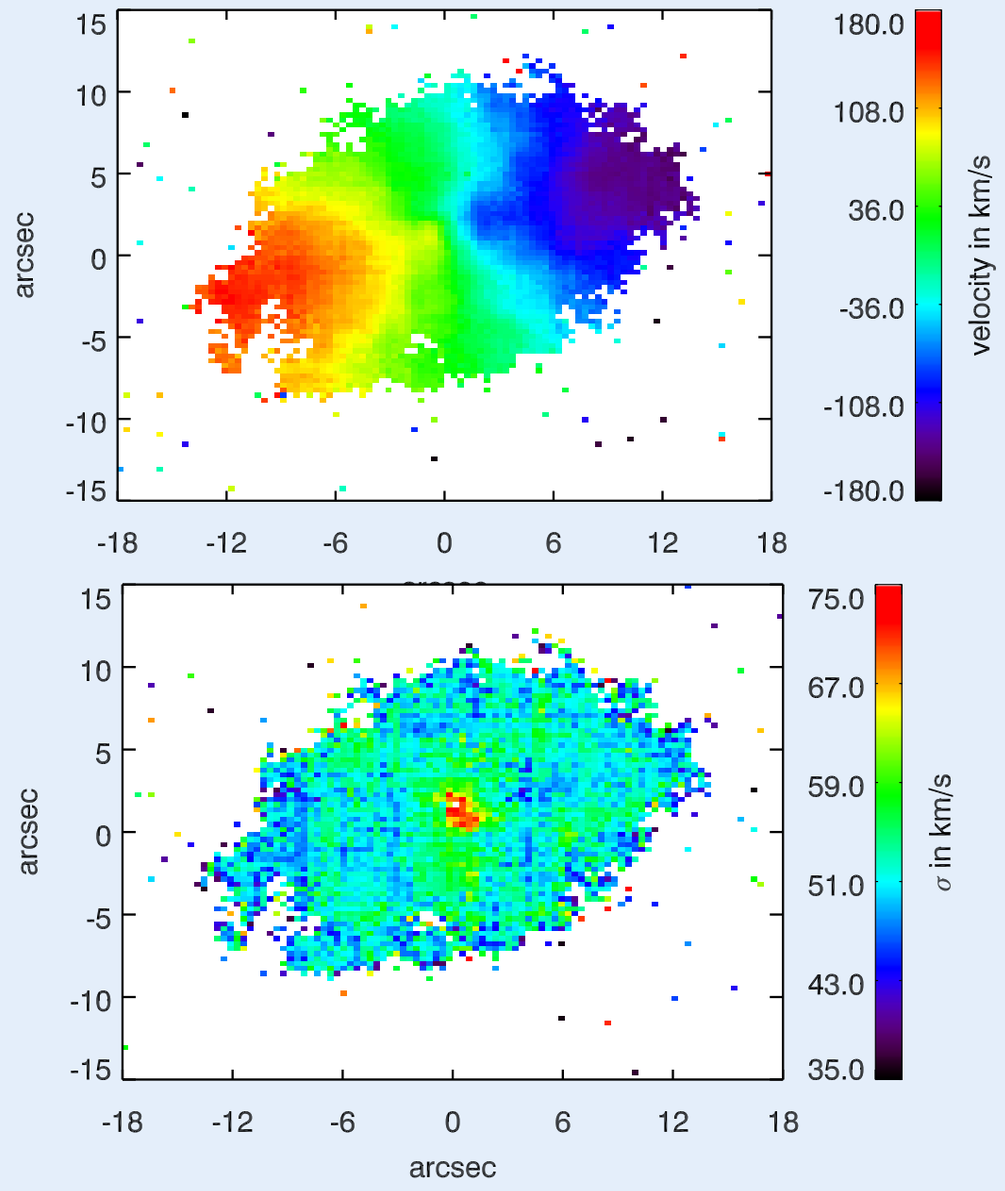


Thöne et al. in prep.

The host

- Barred spiral, GRB in HII region in spiral arm
- Regular velocity field
- Rather average SF spiral, GRB not at special position —> why here??

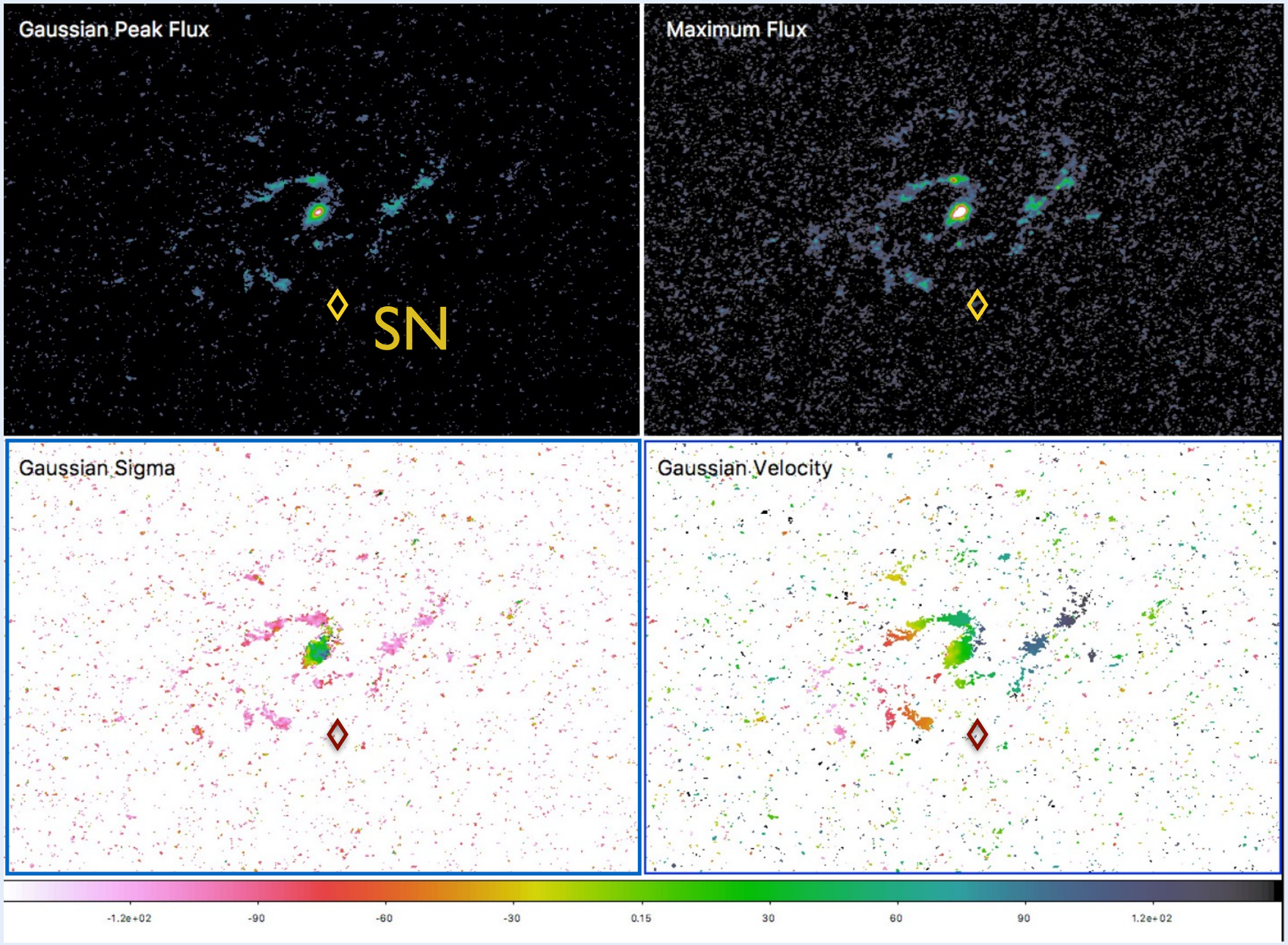




de Ugarte Postigo et al. in prep.

The first resolved CO maps …

4.8h with ALMA at 0.2“ resolution



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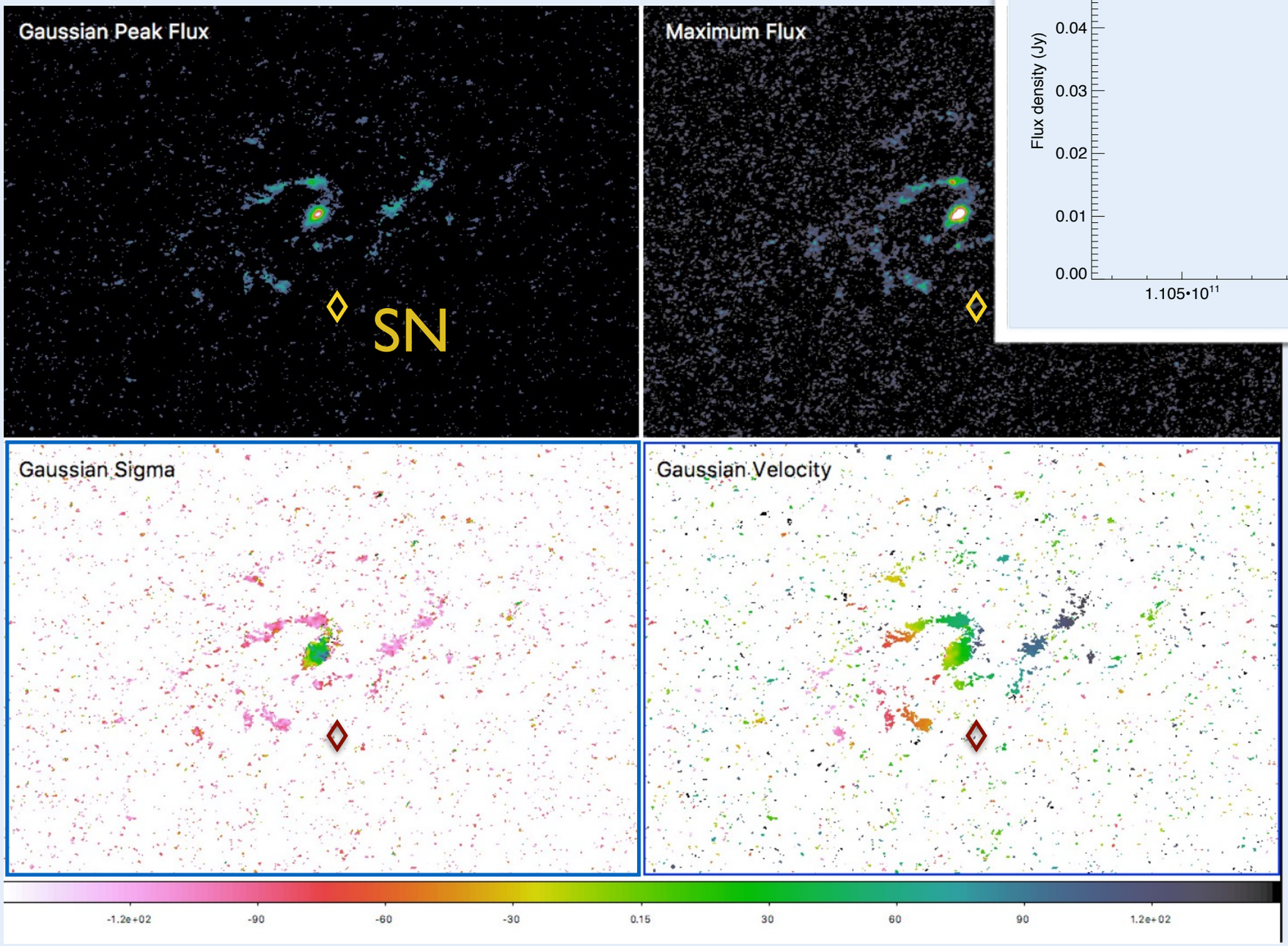
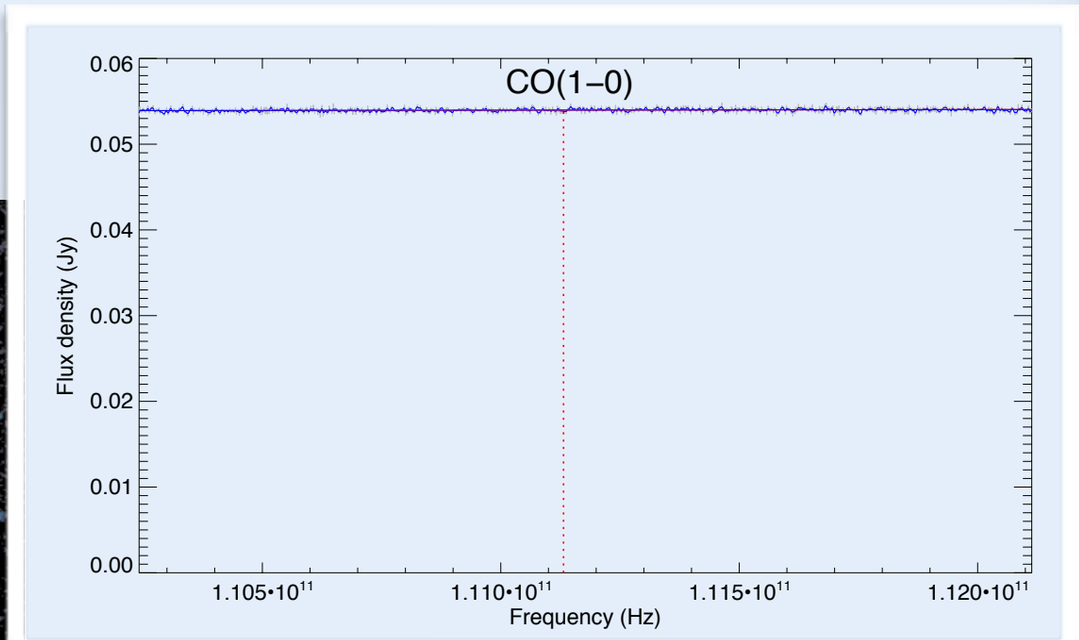
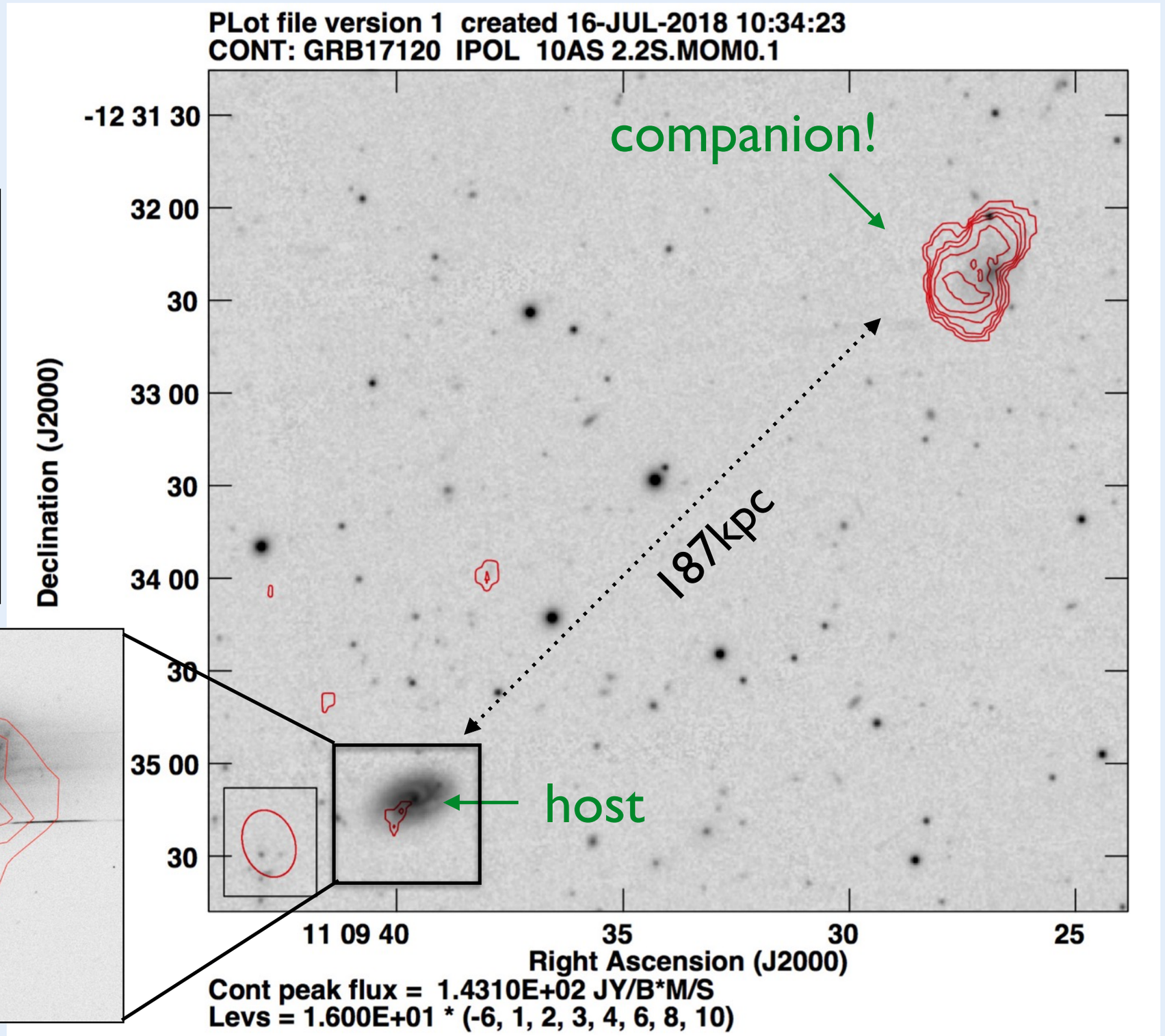




de Ugarte Postigo et al. in prep.

… and a curious HI discovery

14h GMRT



Conclusions

- Earliest GRB-SN spectrum ever showing very broad features
- Material from GRB jet-cocoon observed for the first time
- Fortunate case (weak AG, low z..?) or are there more?
- Large follow-up: new „standard“ for GRB-SNe?
- Interesting spiral host with lots of data (IFU, CO, HI)
- Can gas fueling via interaction explain the unusual host??