Radiation-driven and wind-blown HII regions and their feedback to the environment

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Motivation: Massive stars affect ISM + galactic evolution most dominantly

- ✓ **Energy:**
  enormous luminosities in all evolutionary stages;
  Feedback: energy input vs. cooling
  negative star-formation feedback
- ✓ **Dynamics:**
  energy release stirs-up the ISM
  - gas compression, turbulence, mixing, galactic winds
  - star-formation feedback positive + negative
- ✓ **Chemistry:**
  rapid release of mainly α- elements thru SNe type II, but also CNO self-enrichment by WR winds
  (consequences for CNO abunance determinations + early enrichment of the Universe)

2d models of radiation-driven + wind-blown HII Regions:

- ✓ **Method:**
  - 2d radiation-HD numerical simulations,
  - nested-grid code:
    e.g. for a 85 M⊙ star: 6 levels Δx = 0.0074 … 0.24 pc
  - stellar evolutionary models:
    Langer (Garcia-Segura et al. 1996), Schaller et al. (1992)
- ✓ **Model conditions:** $n_{ICM} = 20\ cm^{-3}$ $T_{ICM} = 200\ K$
- ✓ **Pub.s:**
  15 $M_\odot$ (Kroeger, 2007, PhD thesis)
  35 $M_\odot$ (Freyer, G.H., Yorke, 2006, ApJ, 638, 262)
  60 $M_\odot$ (Freyer, G.H., Yorke, 2003, ApJ, 593, 888)
  85 $M_\odot$ (Kroeger, G.H., et al., 2006, A&A, 450, L5)

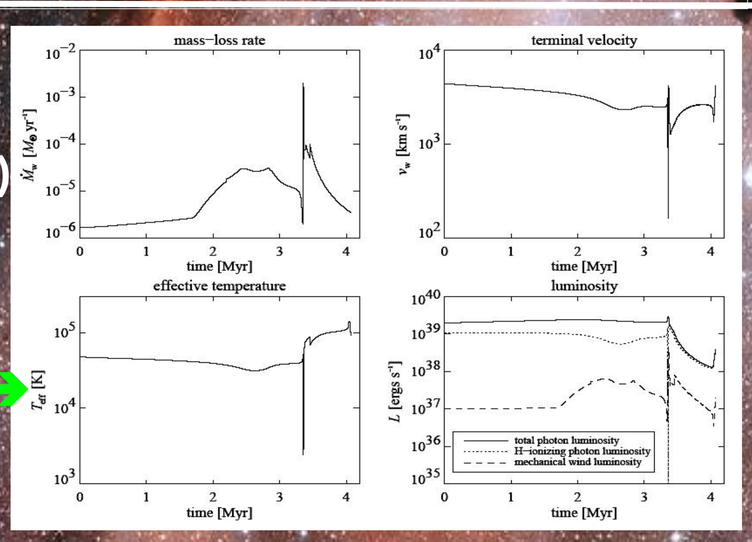
Models:

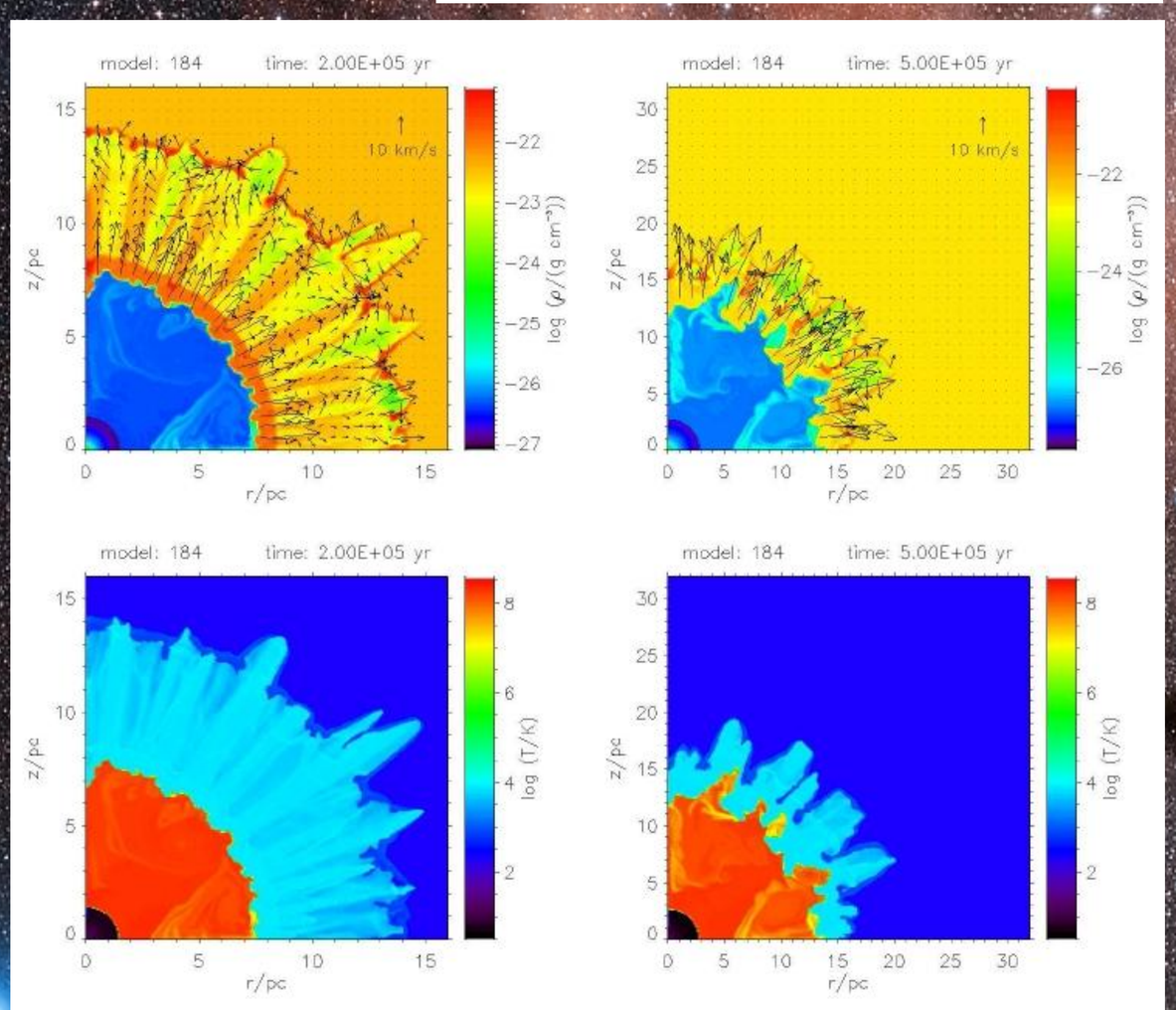
(most impressive for various reasons)

60 $M_\odot$

Lifetime properties →

Cut of ρ,T distr.s ↓

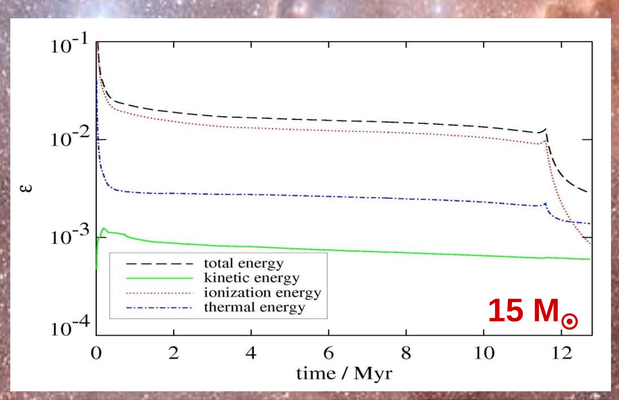


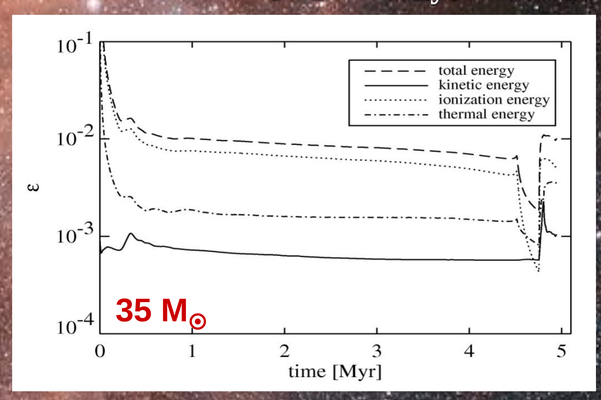


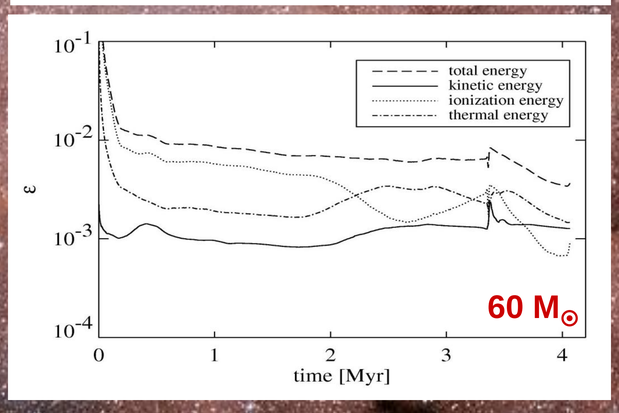
Results on Energies:

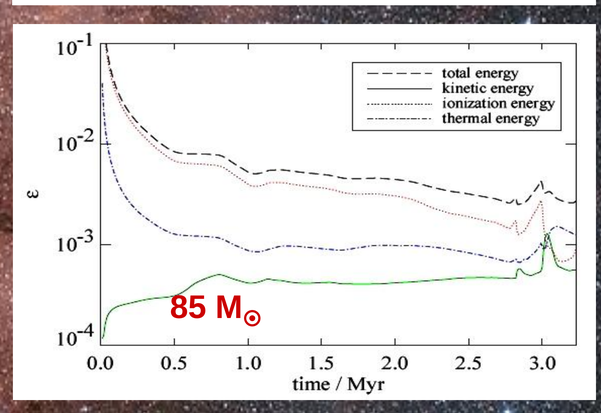
Energy transfer efficiencies for E_i, E_k, E_t ~ 1‰

$$\varepsilon = \sum E_i / [\tau\ (L_{Lyc} + L_w)]$$

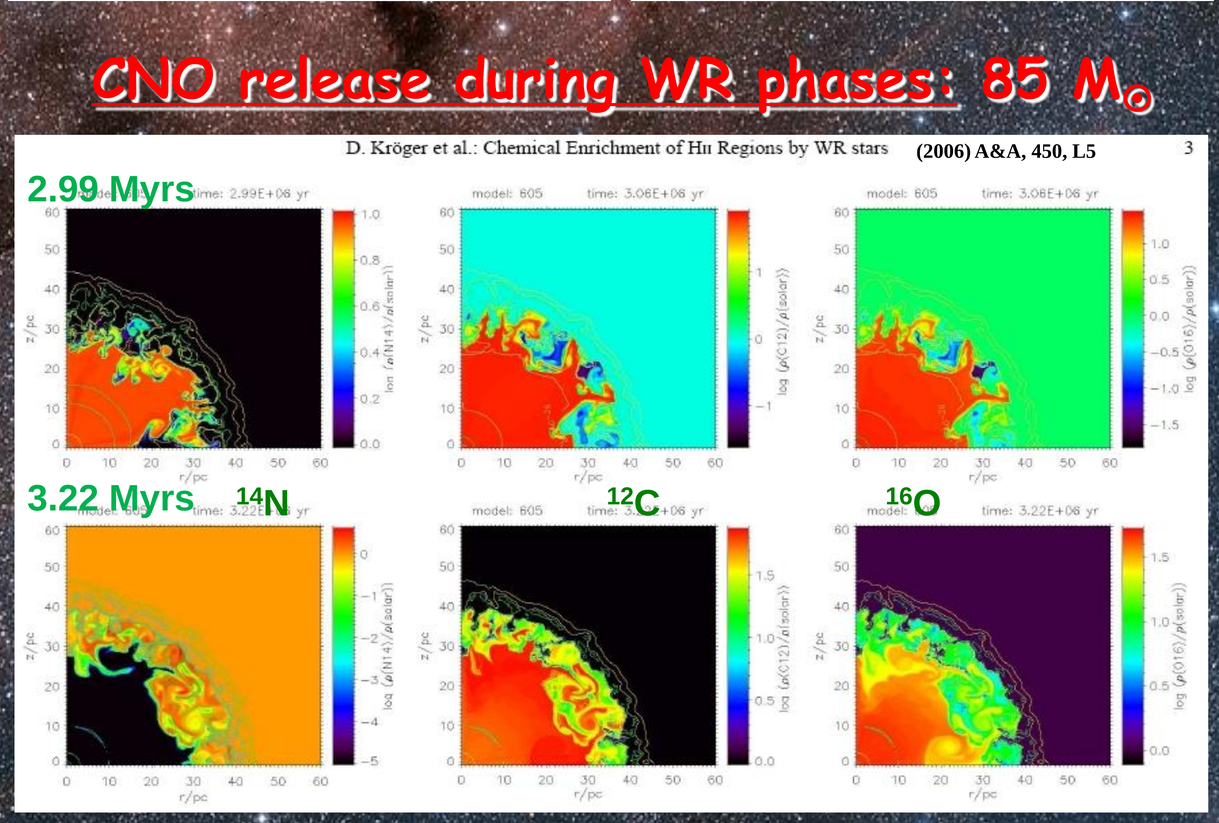








CNO release during WR phases: 85 $M_\odot$



Dynamical results:

- ➢ Hot wind region
- ➢ Outer wind shells structured by Vishniac instab.
- ➢ Ionizing radiation enhances finger-like structures in (observed), but not for 15 and 85 $M_\odot$
- ➢ complex structures: ionized shells around the wind bubble, density and temperature fluctuat.s
- ➢ Mixing of photo-evaporated gas with hot one
- ➢ Wind gas must cool to mix into the warm HII gas.
- ➢ Only C is significantly enriched in the optical line-emitting HII region to 23%.