3D Radiative Transfer in Eta Carinae:

the SimpleX Radiative Transfer Algorithm Applied to 3D SPH Simulations of Eta Car's Colliding Winds

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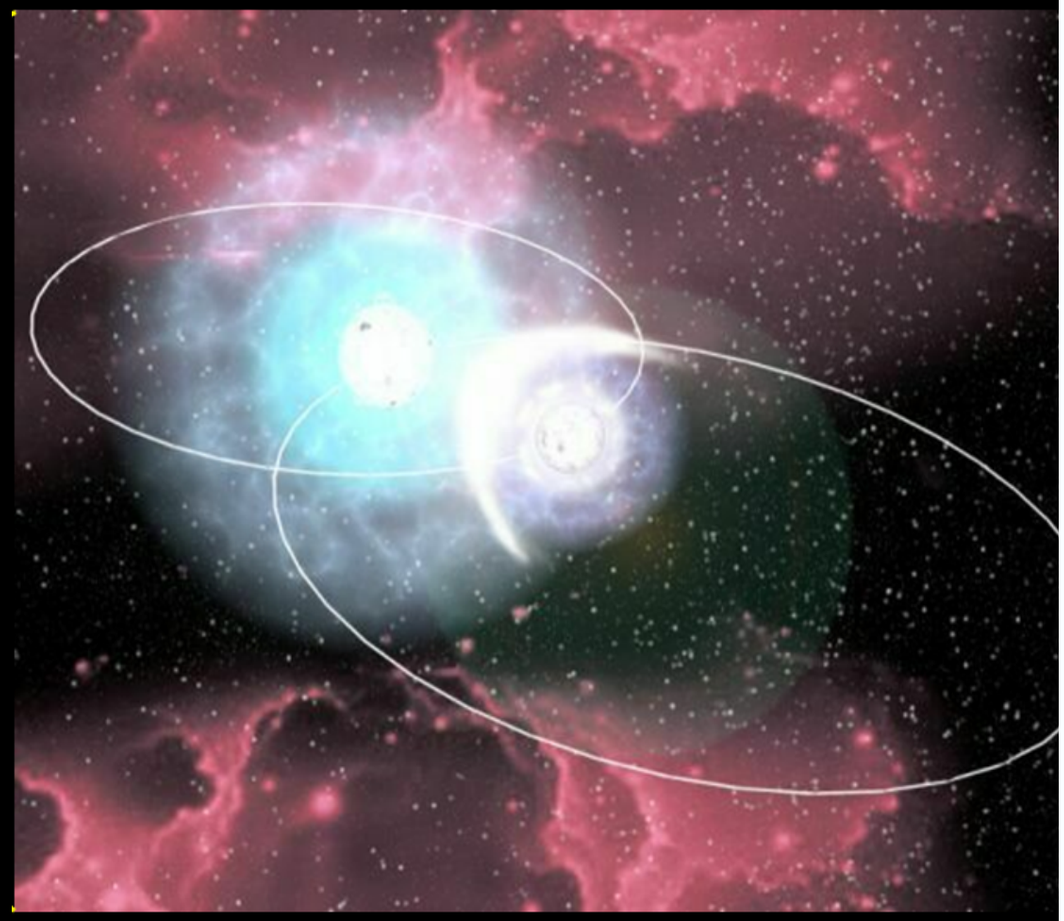
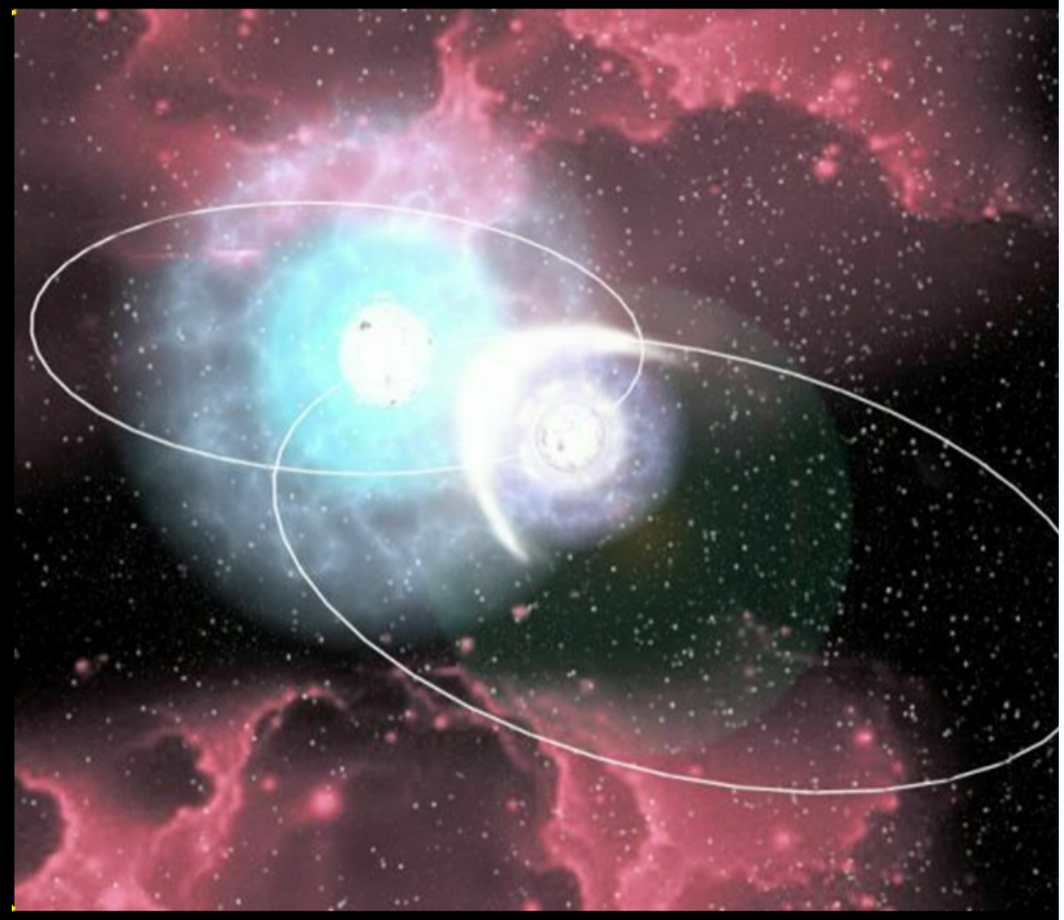
Eta Carinae

Extraordinary death of ordinary star

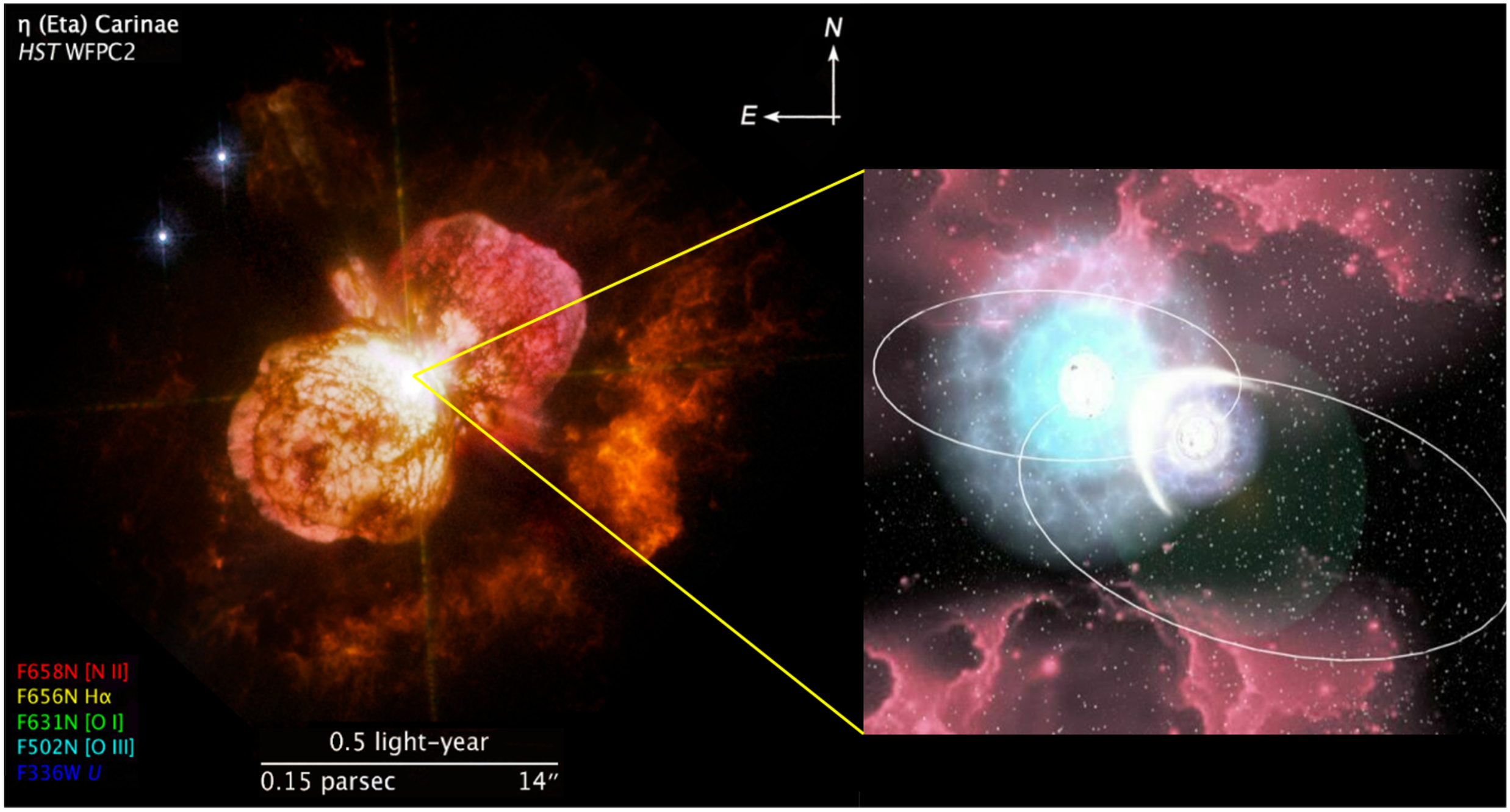


Eta Carinae

Extraordinary “near death” of extraordinary star



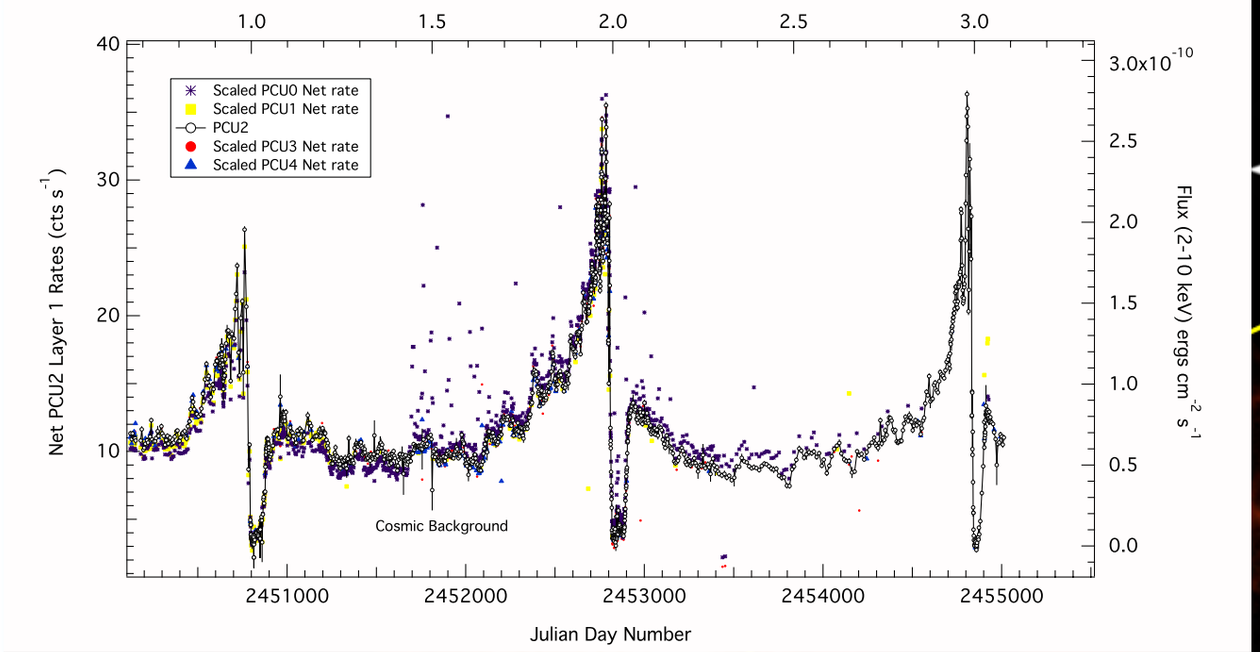
Eta Carinae



HST image of Eta Carinae (NASA, ESA, and the Hubble SM4 ERO Team) with artist's conception (A. Damineli, www.etacarinae.iag.usp.br)

Eta Carinae

Corcoran et al. 2010



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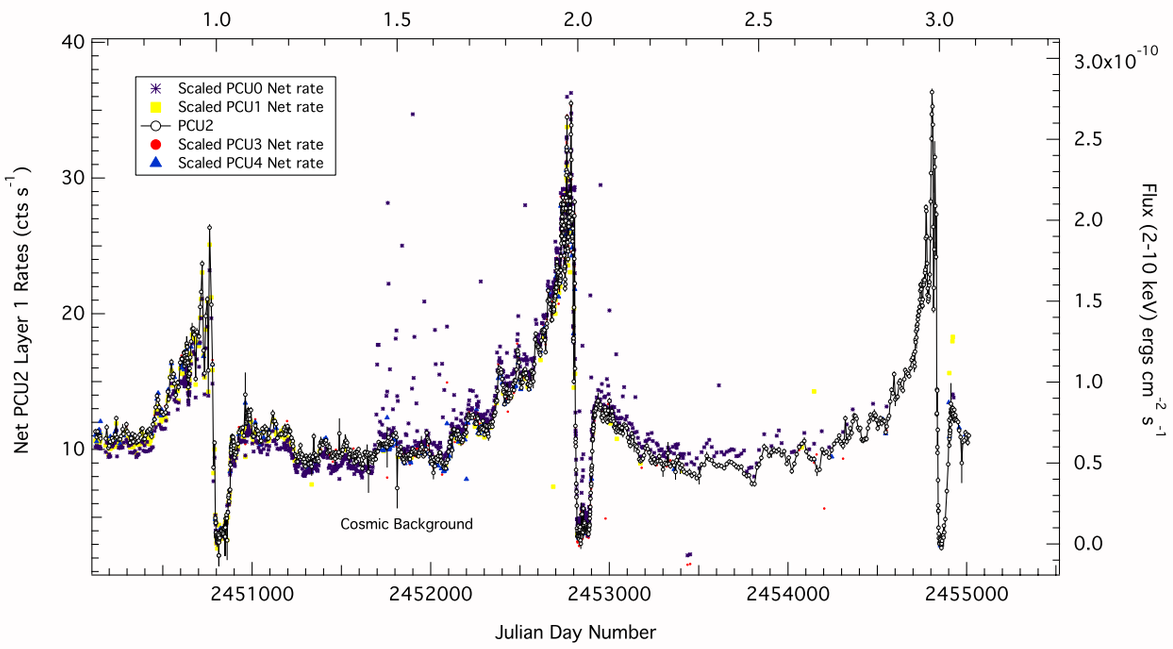
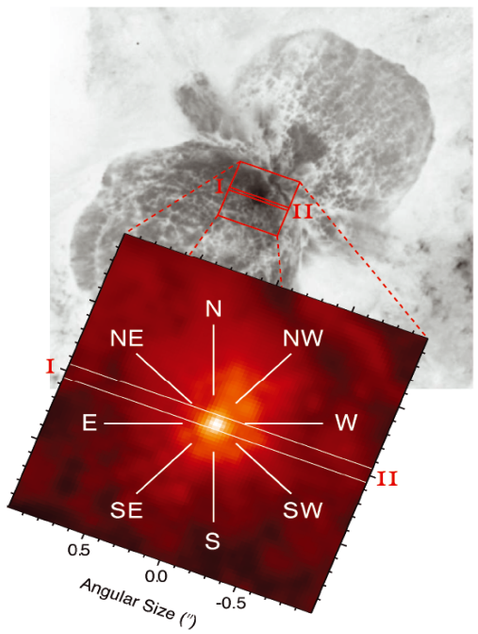
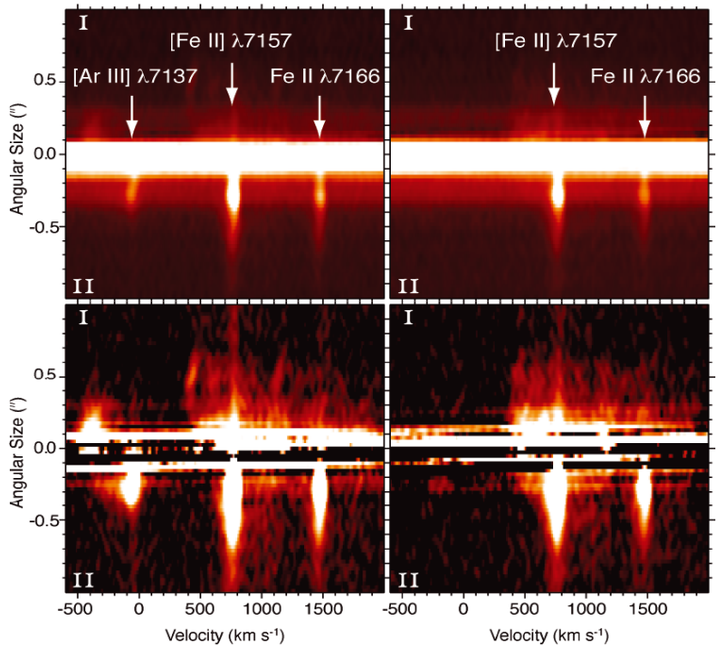
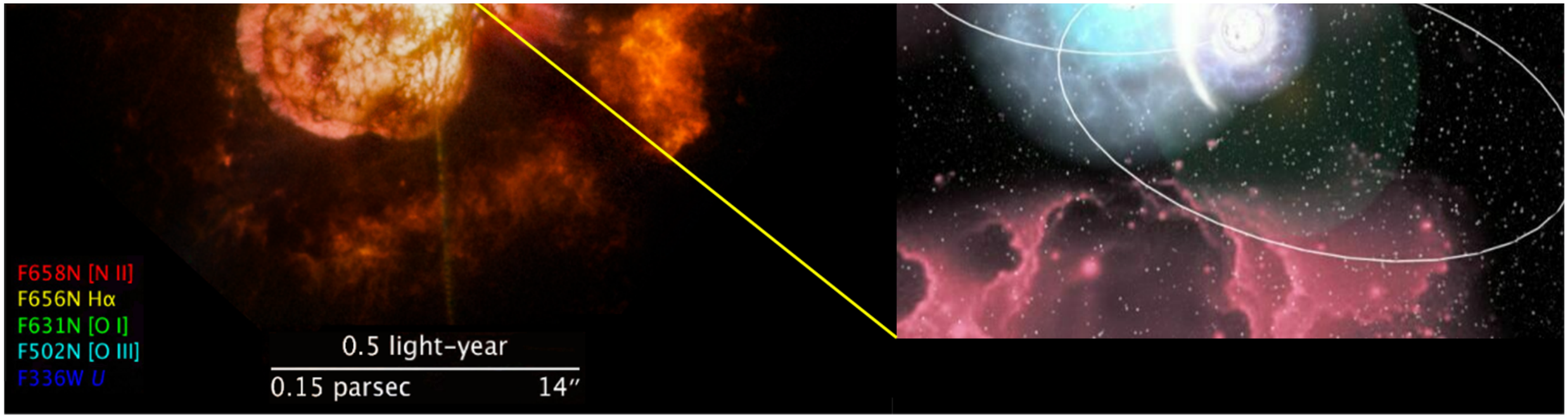




Gull et al. 2009





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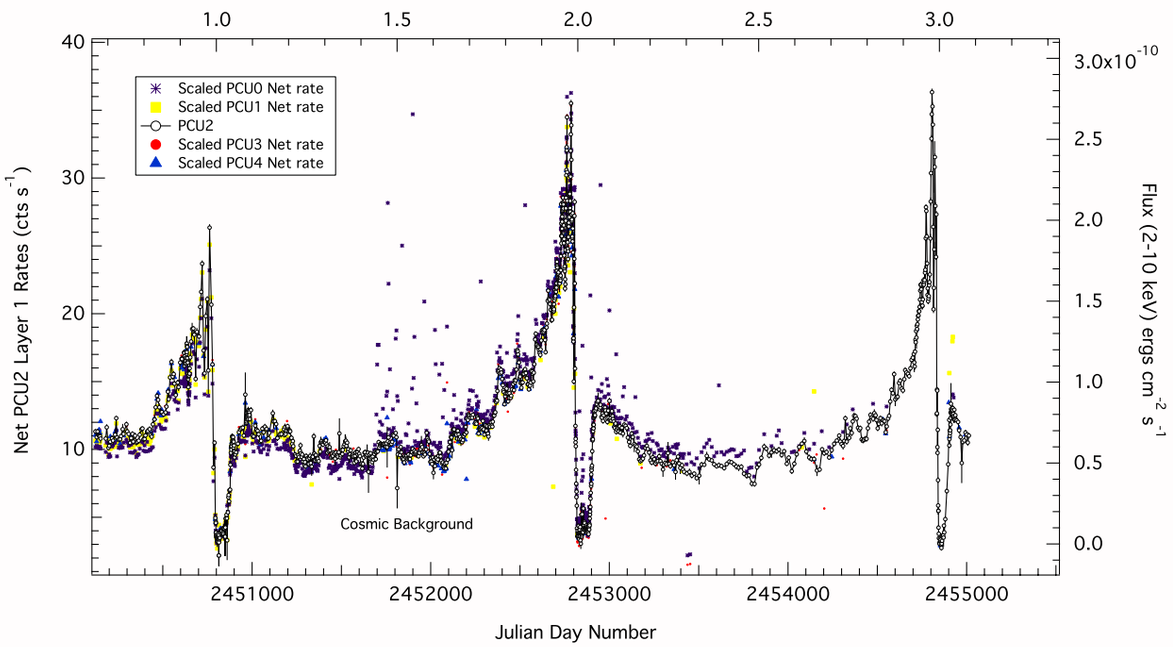
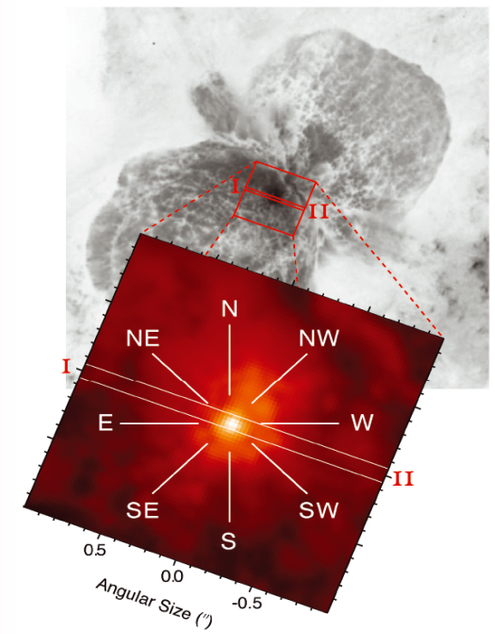
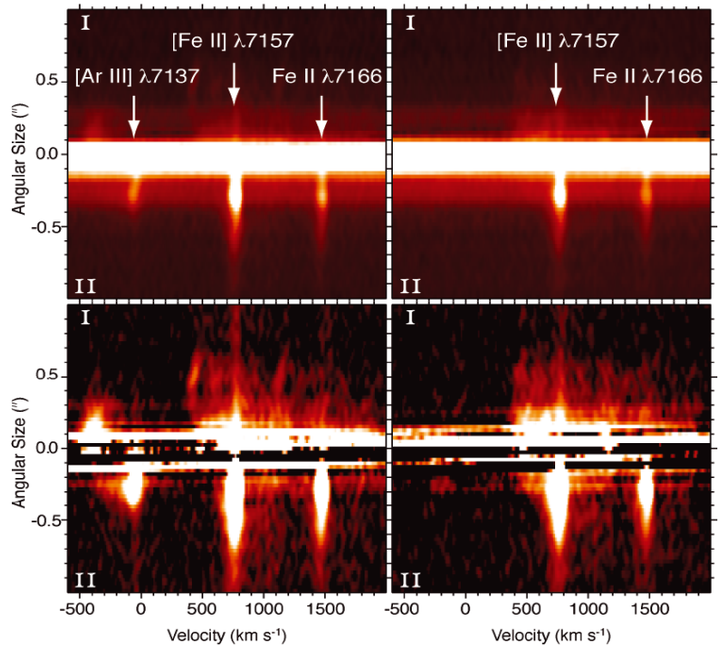
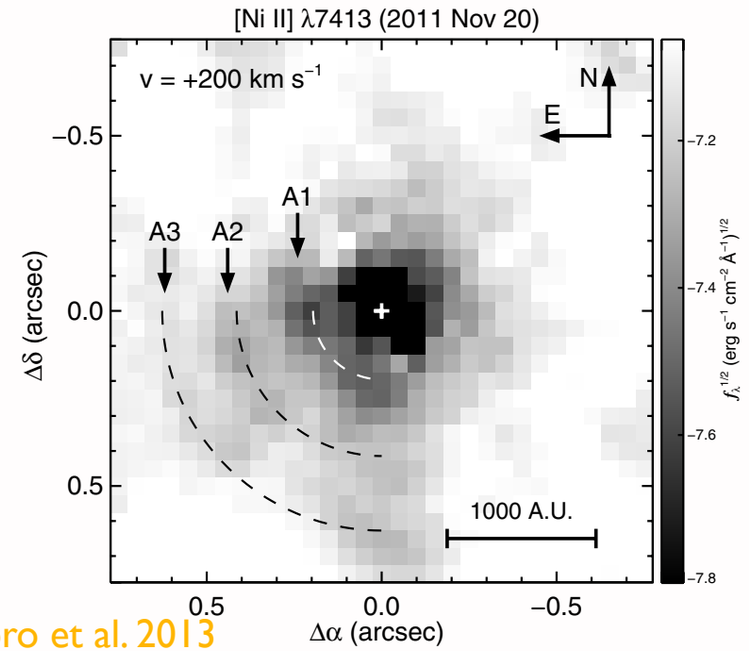


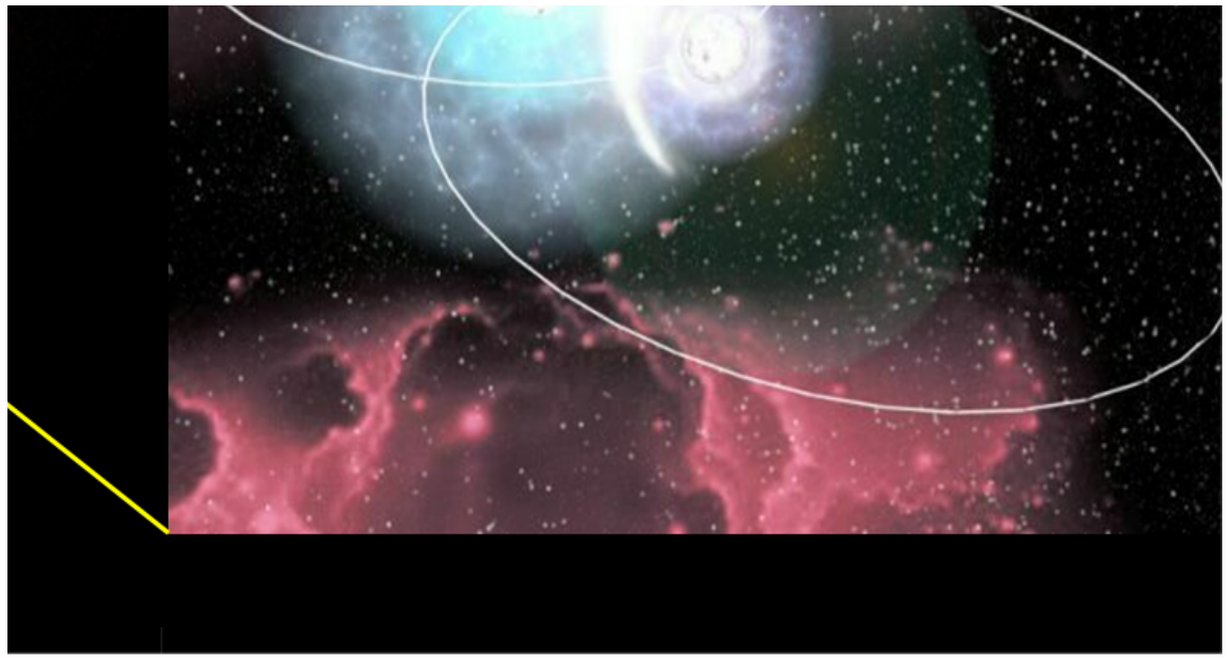


Gull et al. 2009





Teodoro et al. 2013



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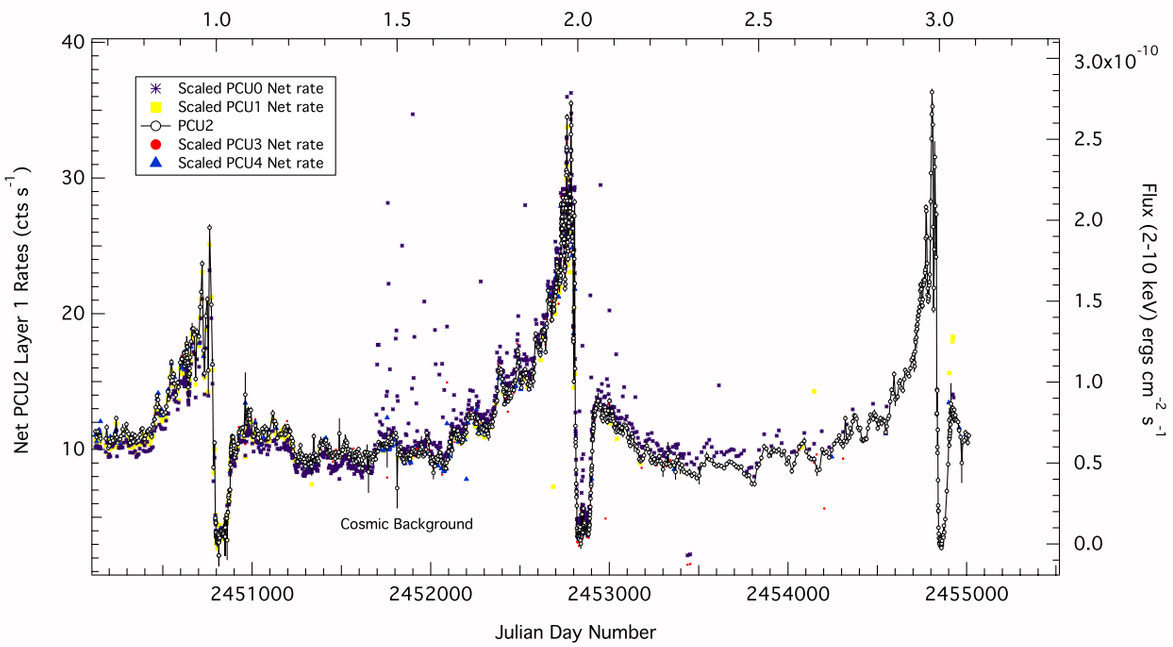
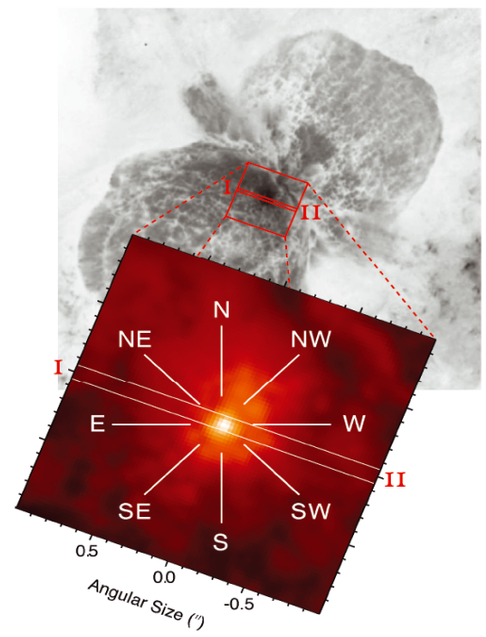
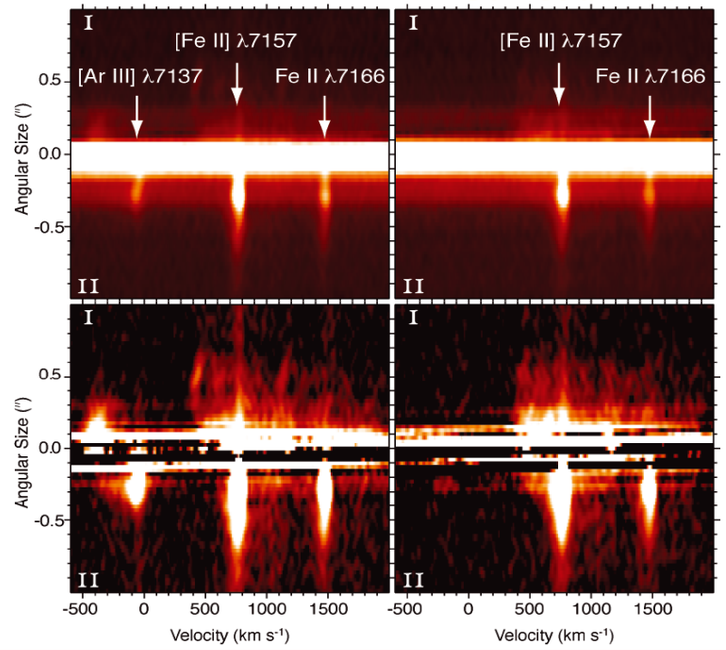
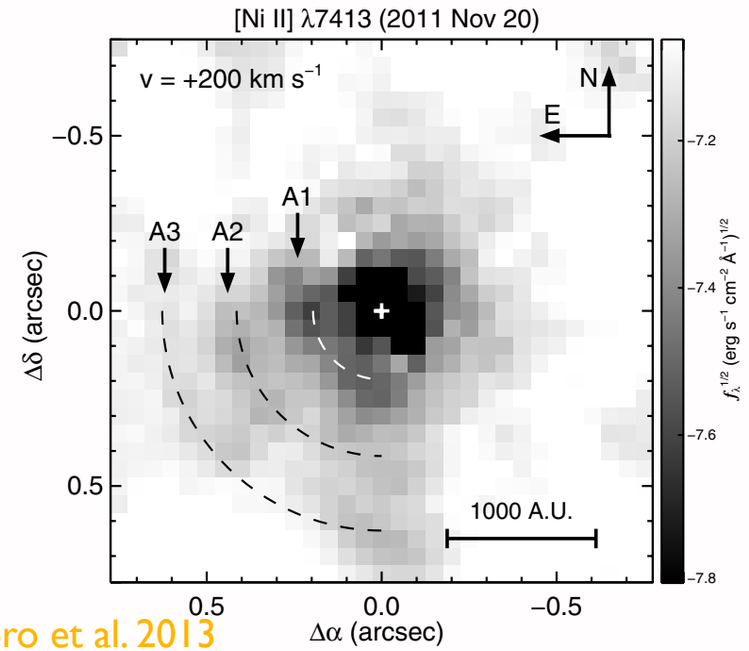


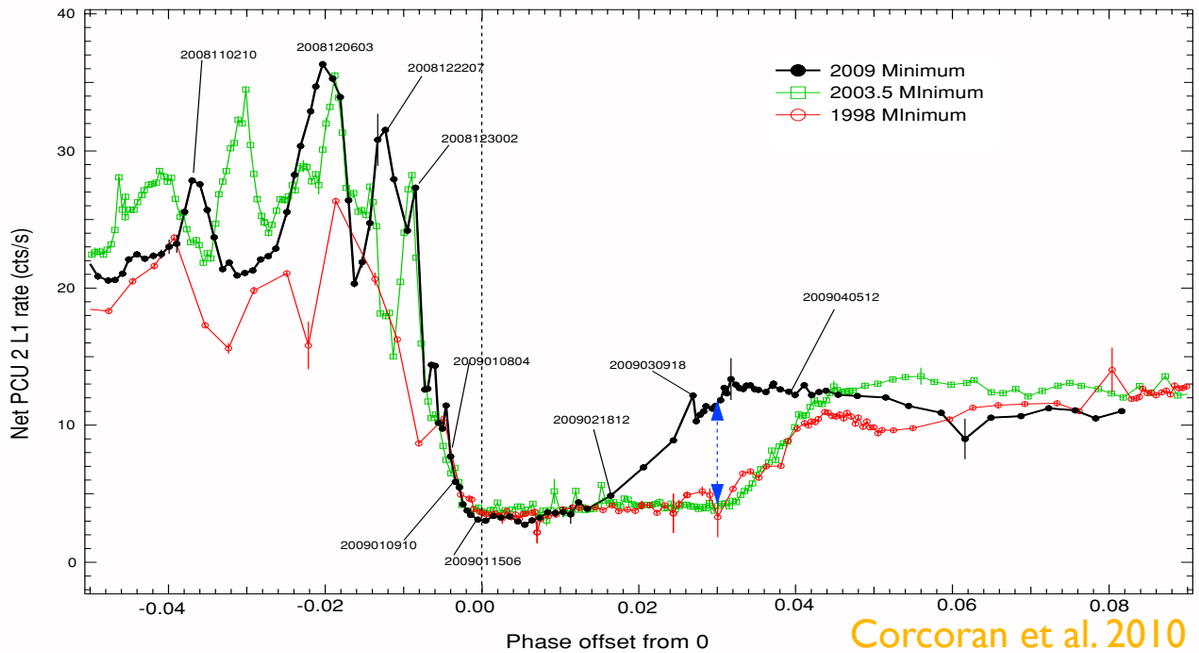


Gull et al. 2009





Teodoro et al. 2013



Corcoran et al. 2010

Eta Carinae

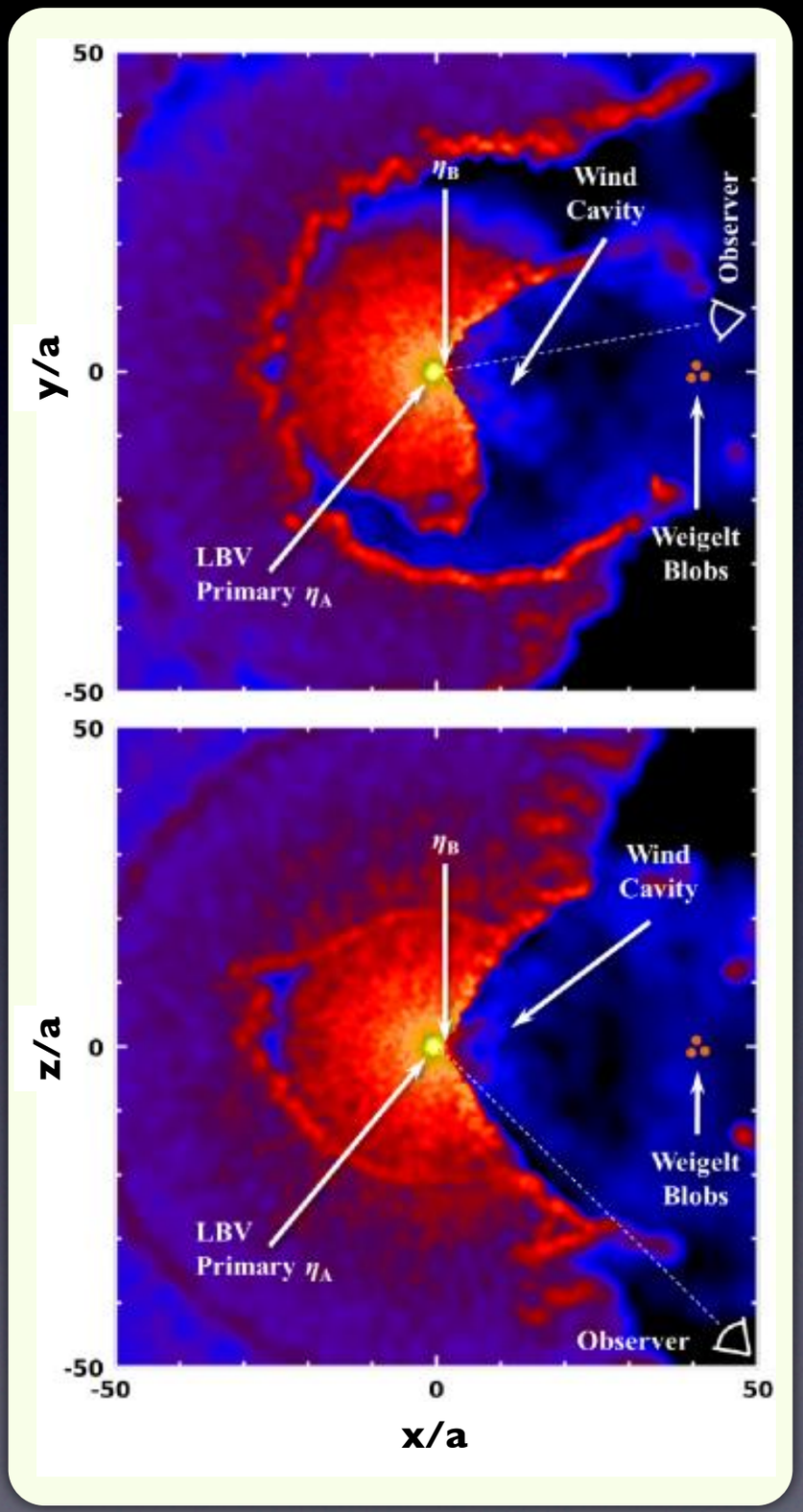
	η A	η B
Mass ($M_\odot$)	90	30
Radius ($R_\odot$)	60	30
$\dot{M}$ ($10^{-4} M_\odot$/yr)	8.5, 4.8, 2.4	0.14
v_∞ (km/s)	420	3000
e	0.9	
a (AU)	15.45	
P (days)	2024	

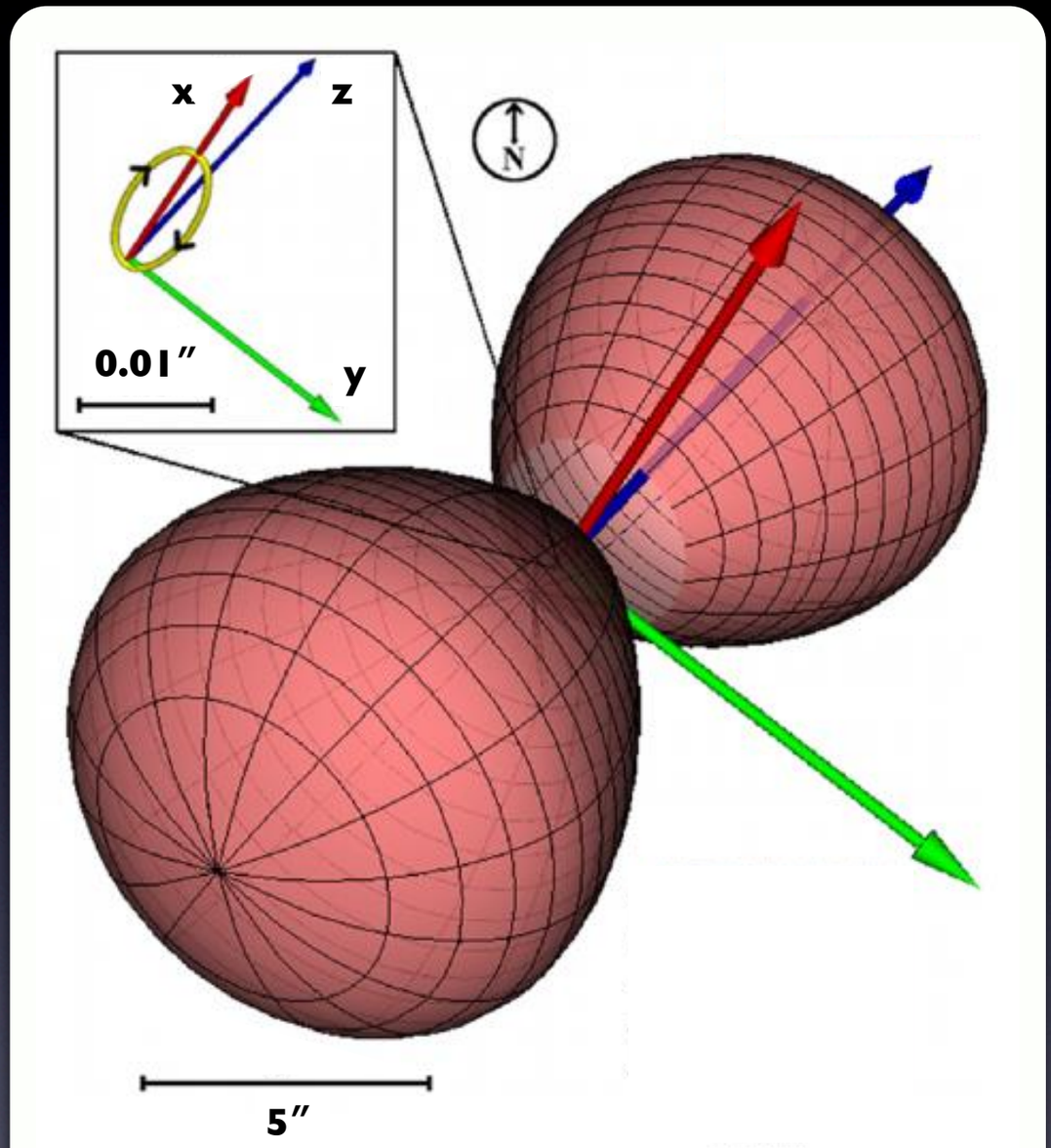
An Ideal Astrophysical Laboratory for:

- Massive Stars Formation and Evolution
- SN Impostors-Progenitors
- Bipolar Nebulae
- Dust Formation

- Colliding Wind Binaries
- Stellar Mass Loss
- Radiative Transfer

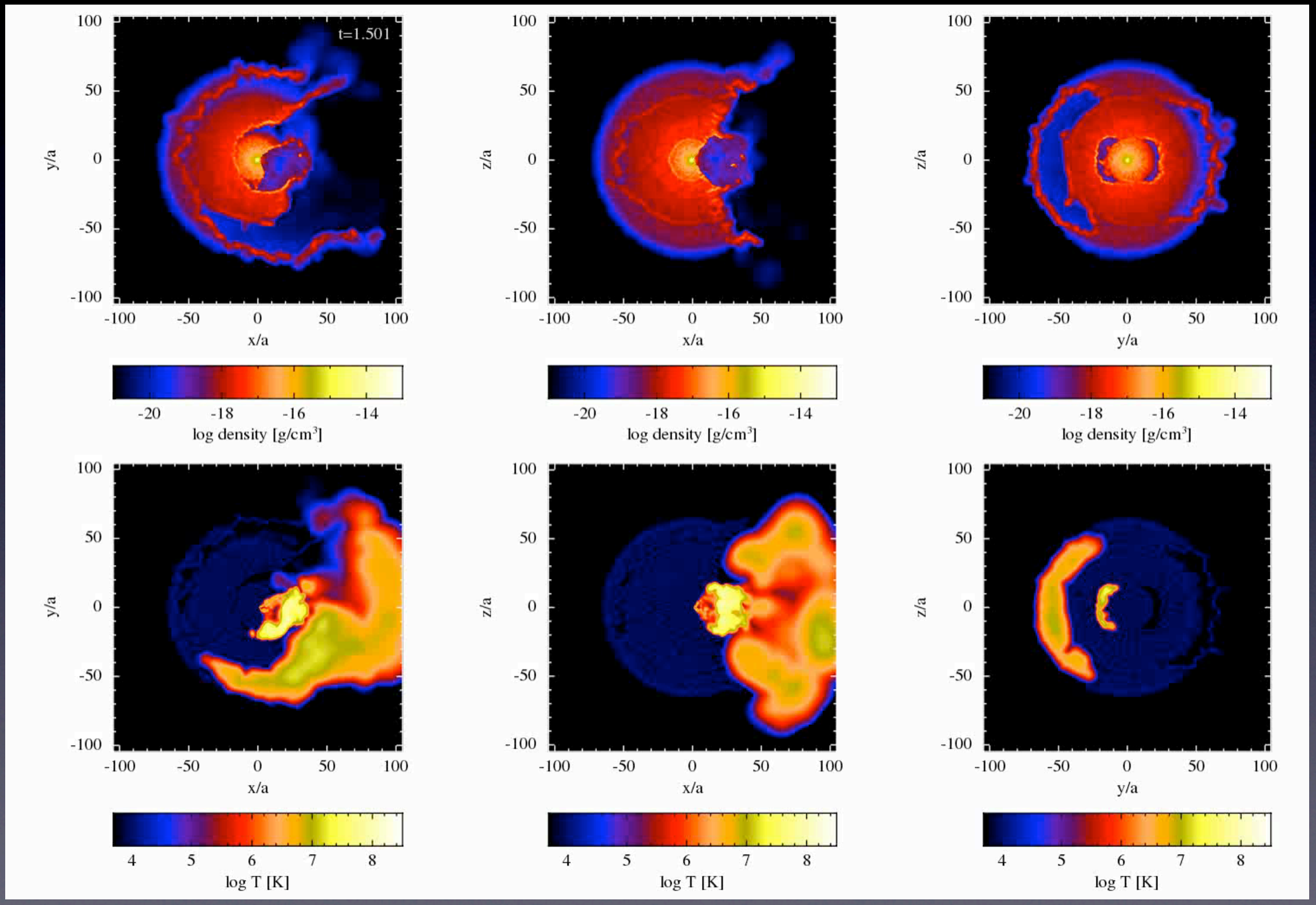
3D SPH Simulations



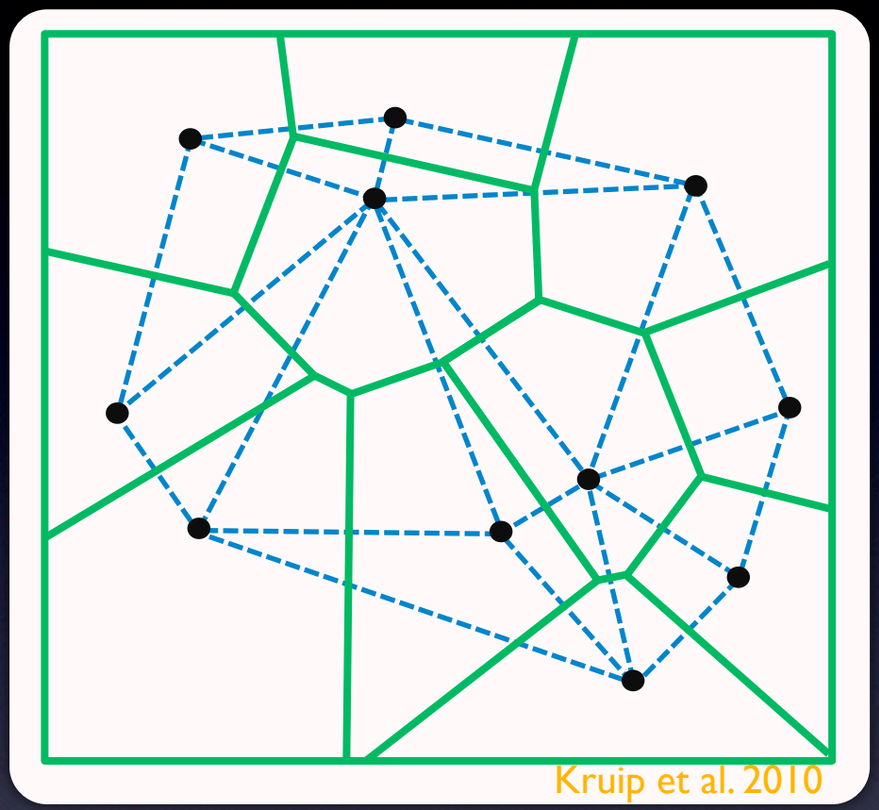


Madura et al. 2013

3D SPH Simulations



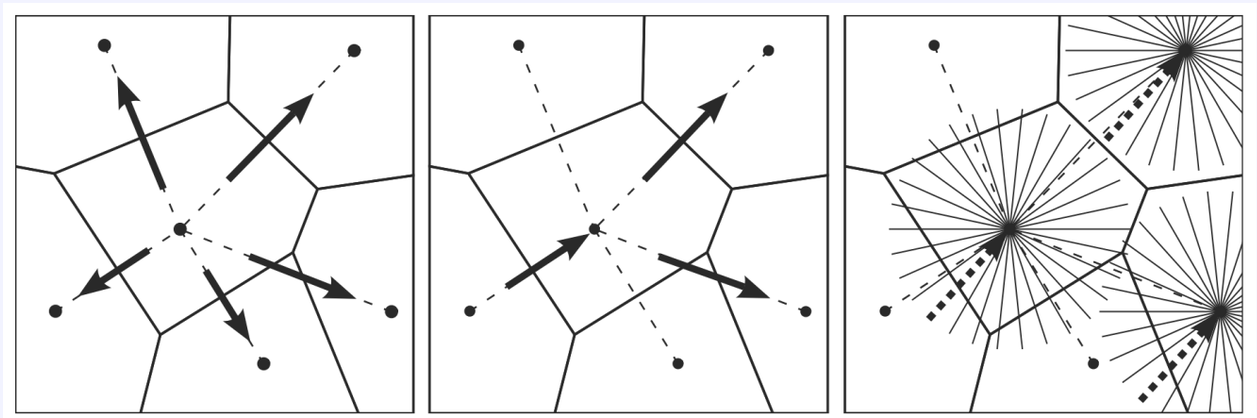
SimpleX



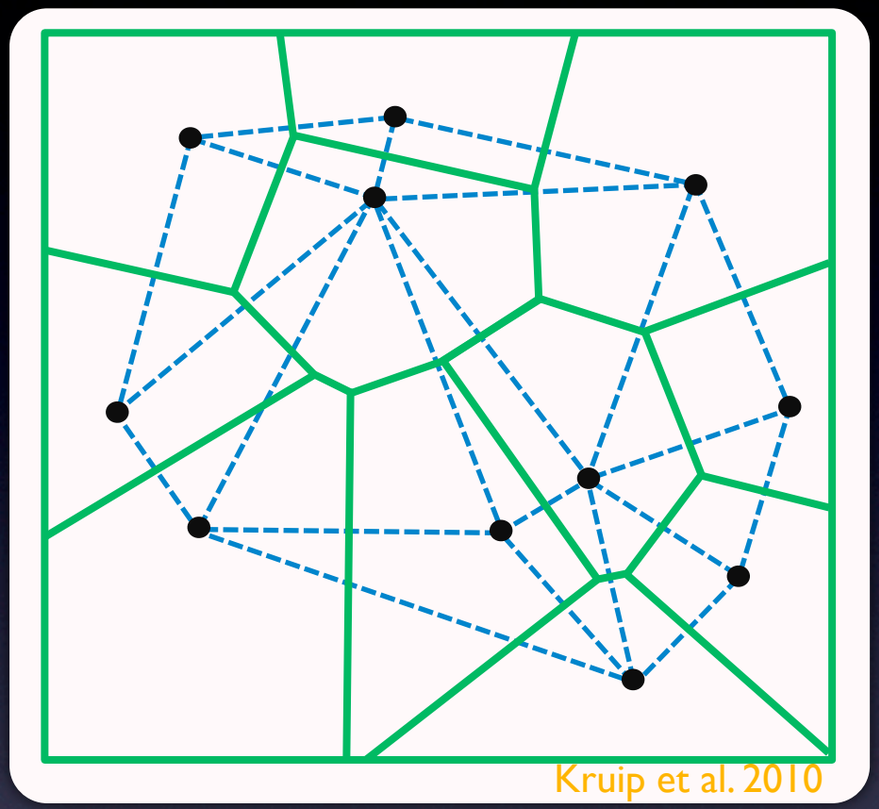
Kruip et al. 2010

- Naturally adapts its resolution to the relevant physical scales
- Compatible with grid base and particle base hydrodynamics codes
- Computationally cheap because of the local nature of the Delaunay transport
- Parallel

- Post-processing
- Every SPH particles as a node
- Delaunay Triangulation Field Estimator



SimpleX



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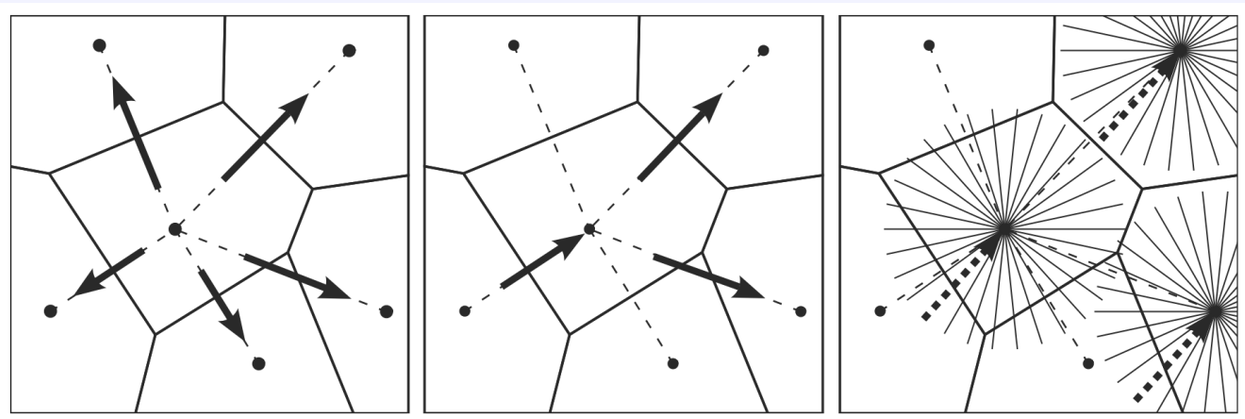
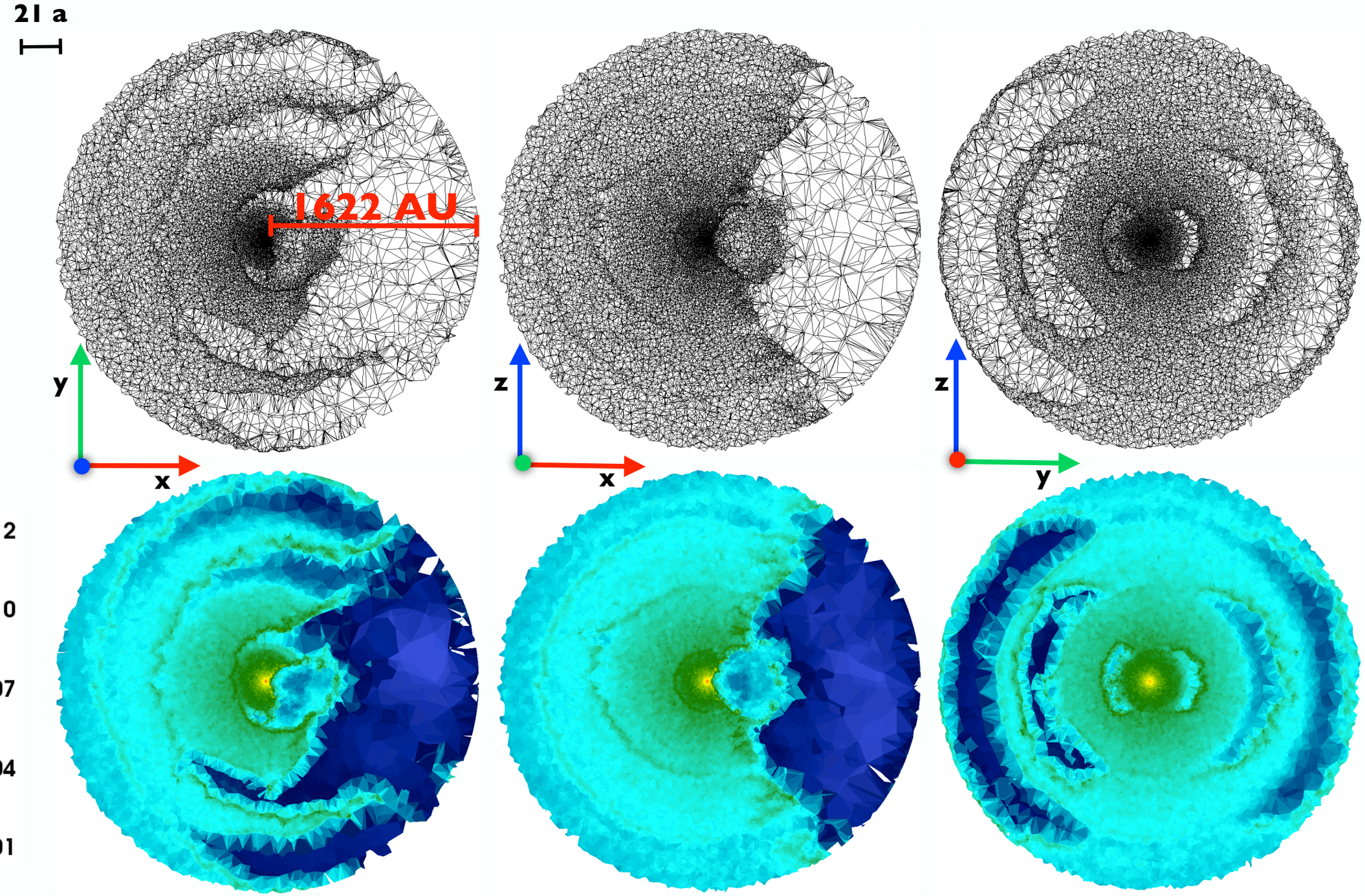
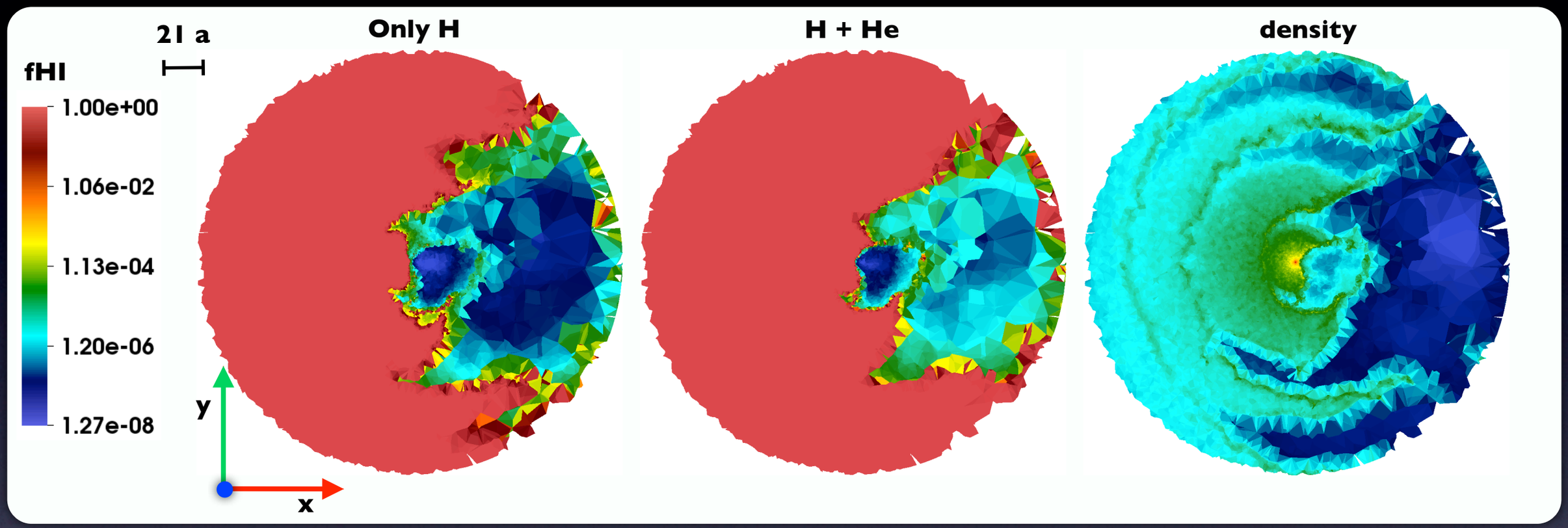


Kruip et al. 2010

SimpleX Mesh



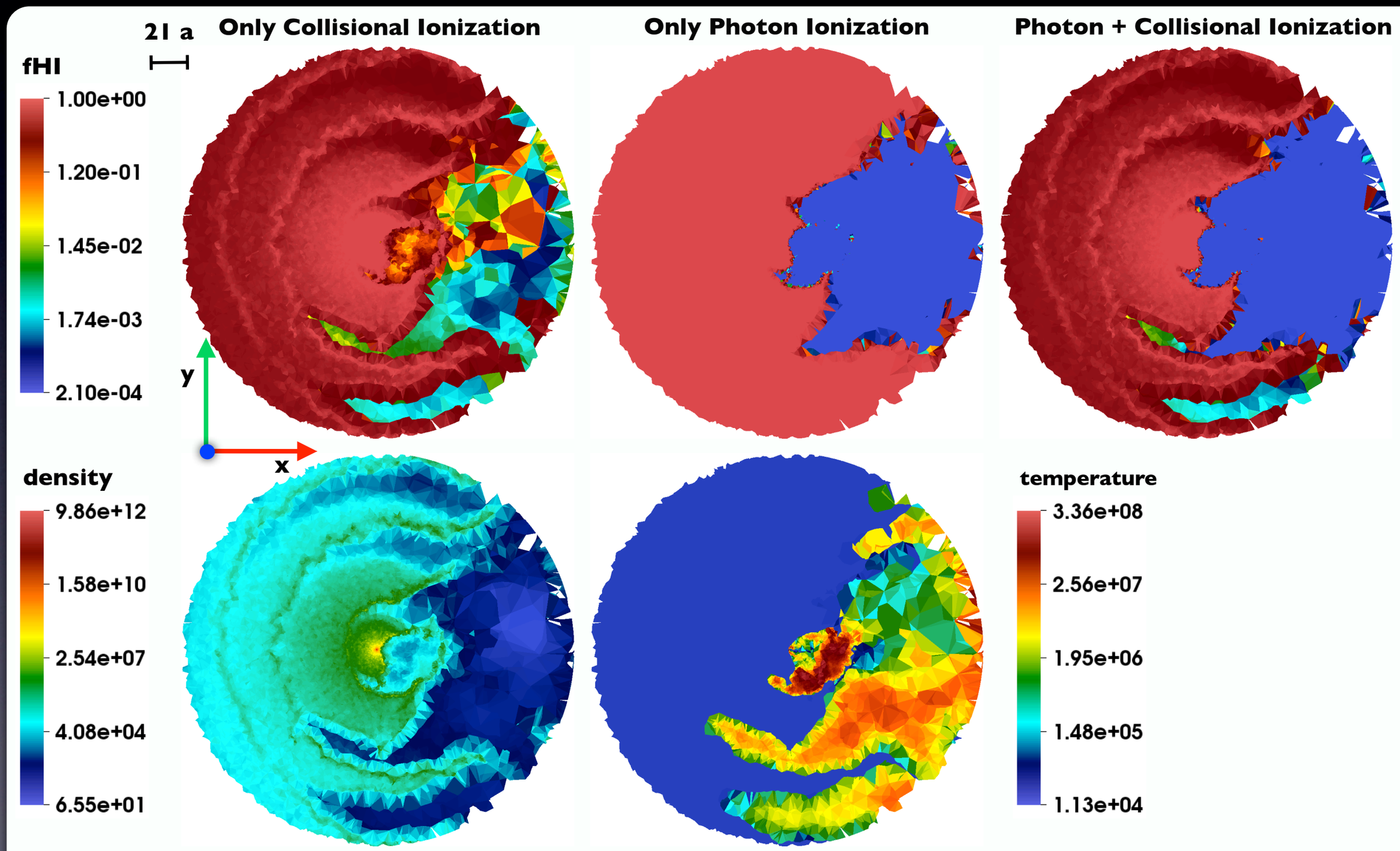
Influence of He



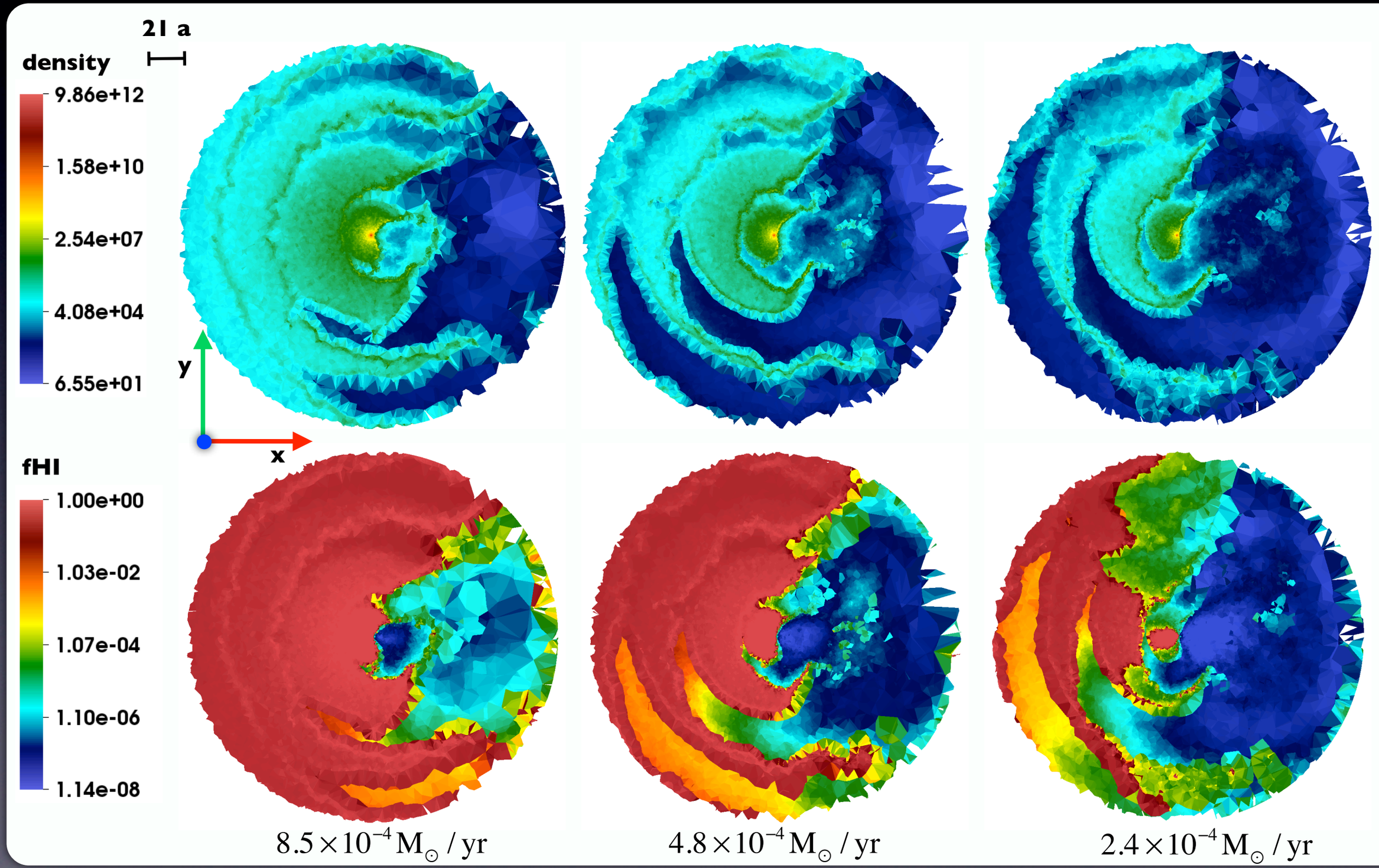
- Snapshots at apastron
- Evolution time = 3 months
- ηB luminosity = 3.02 ×10^{49} photons s^{-1} (O5 giant with T_{eff} ≈40000 K)
- nHe / nH = 0.2

Clementel et al. 2014 in prep.

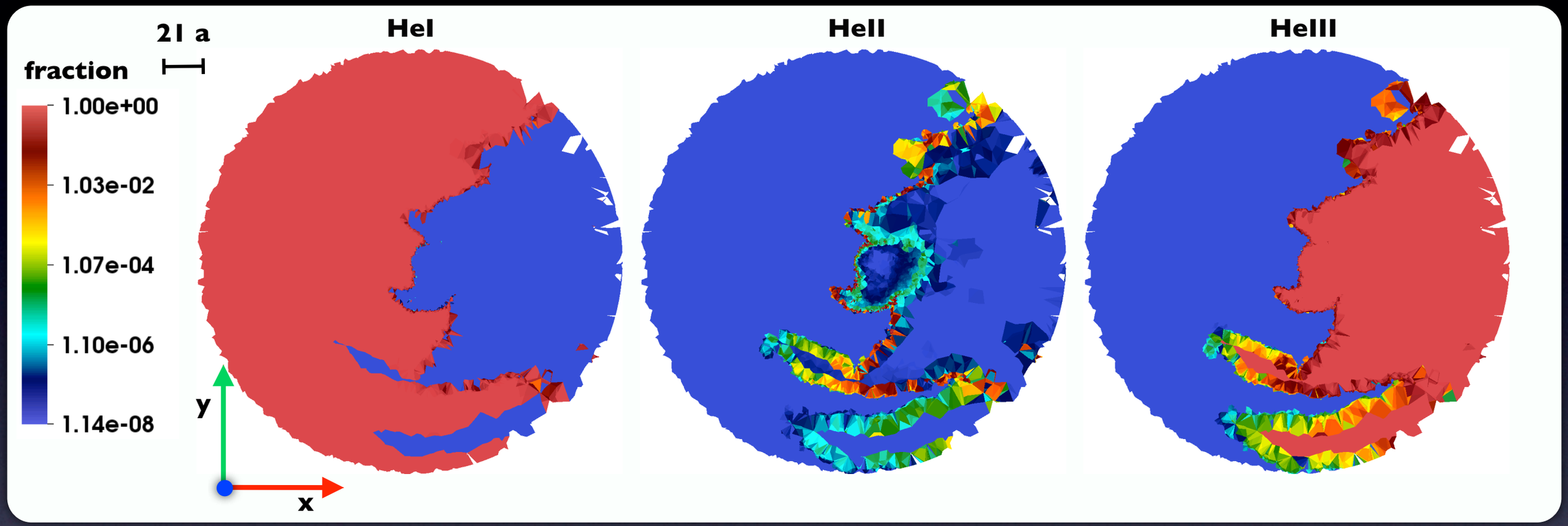
Collisional Ionization



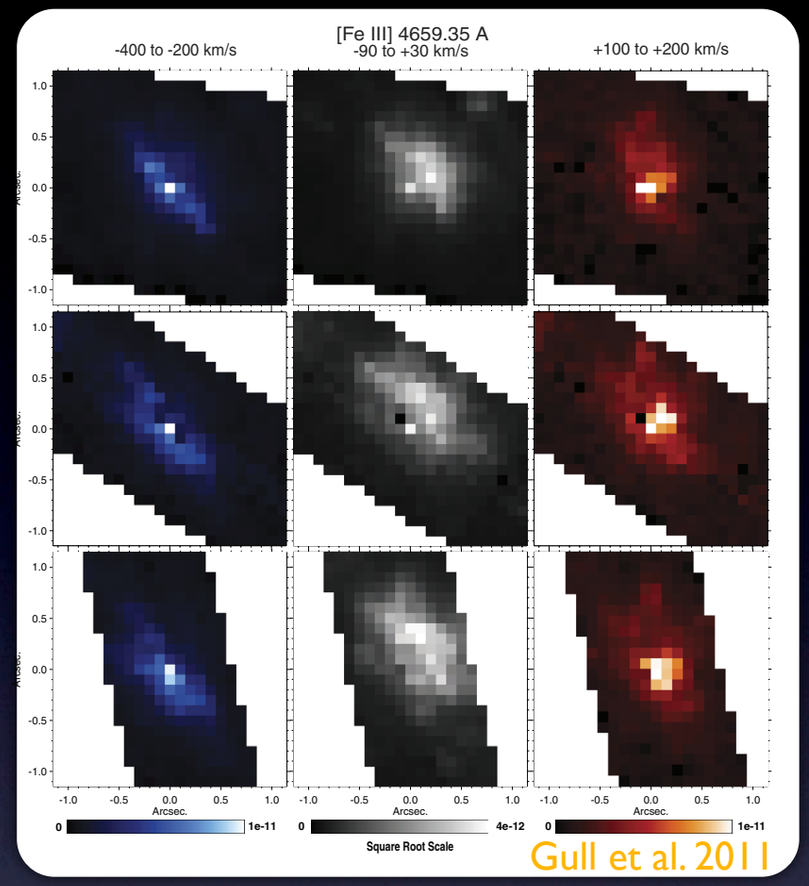
Mass Loss


21 a
density
9.86e+12
1.58e+10
2.54e+07
4.08e+04
6.55e+01
y
x
fHI
1.00e+00
1.03e-02
1.07e-04
1.10e-06
1.14e-08
$8.5\times10^{-4}\,M_\odot\,/\,yr$
$4.8\times10^{-4}\,M_\odot\,/\,yr$
$2.4\times10^{-4}\,M_\odot\,/\,yr$

He Ionization



Future works



Gull et al. 2011

Short term:

- Multi-cycle HST Observing Program through 2015
  - Create synthetic observation
  - Model Forbidden line emission on different phases

Long term:

- Full radiation-hydrodynamics simulations