# NATURE VERSUS NURTURE:

# THE INFLUENCE OF THE ENVIRONMENT IN THE FORMATION OF ASYMMETRIES

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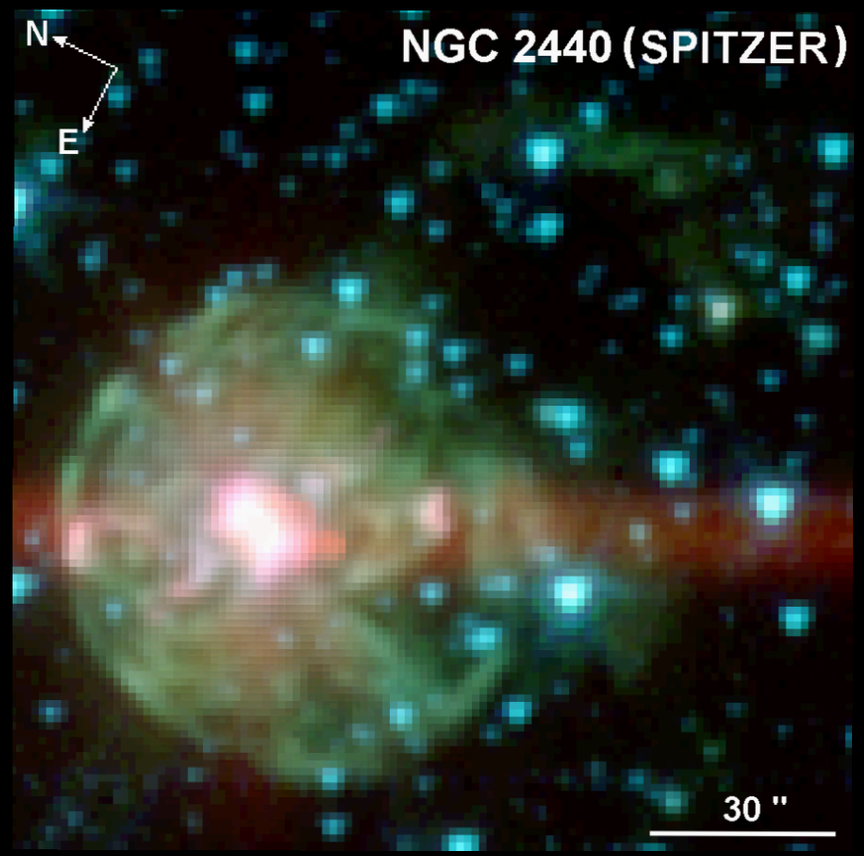
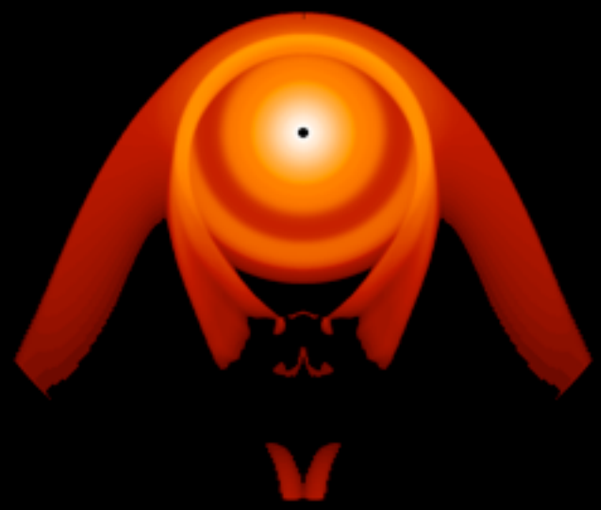
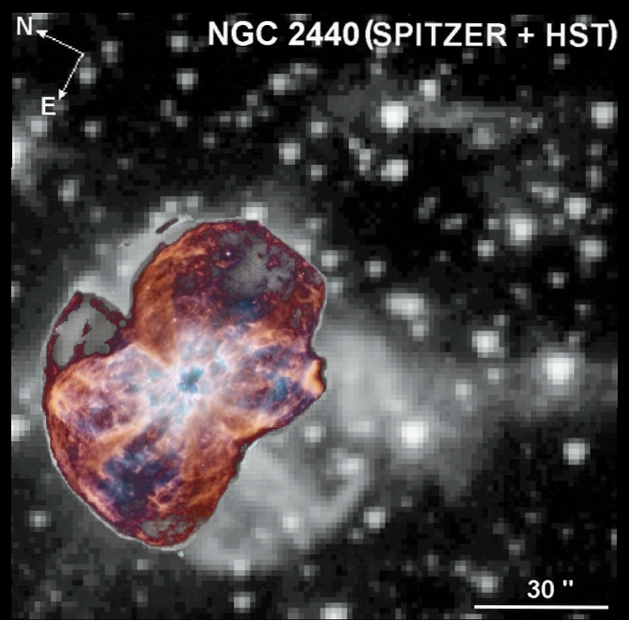
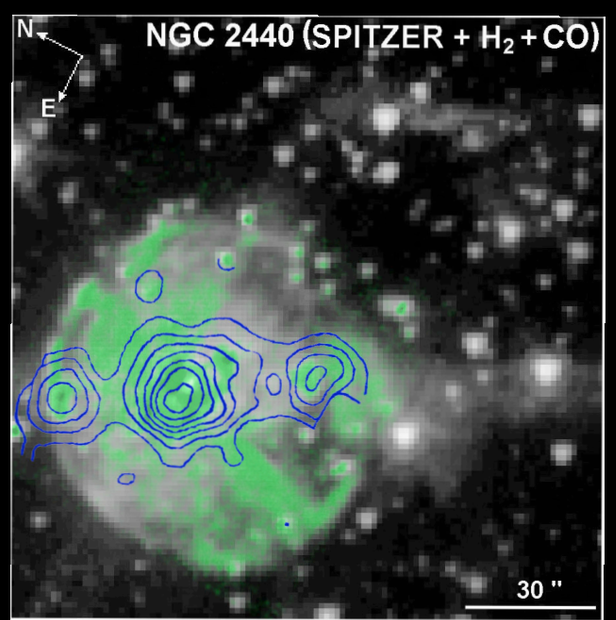


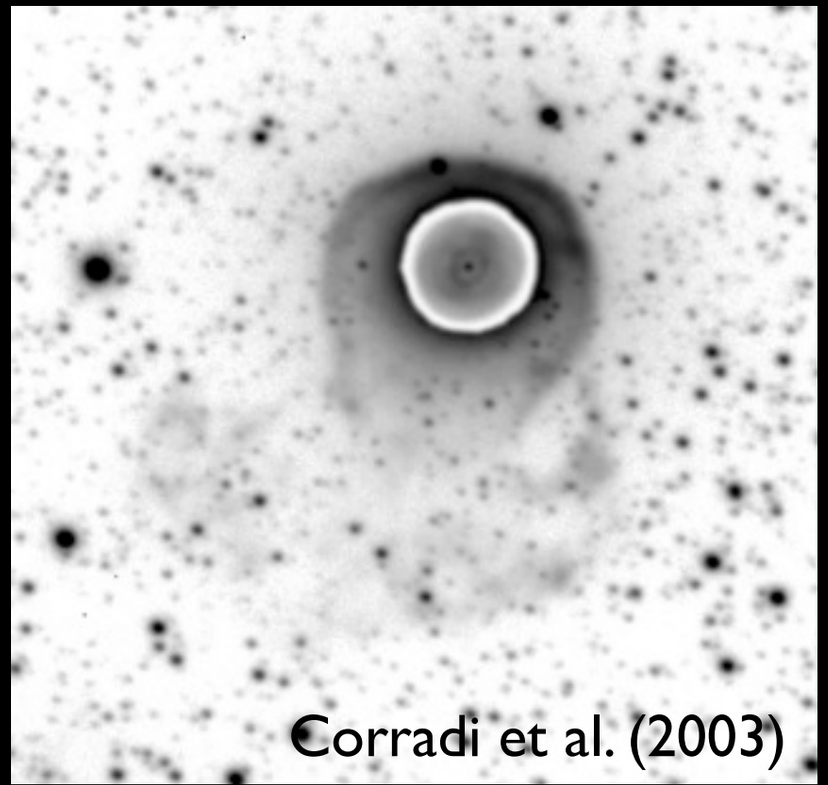



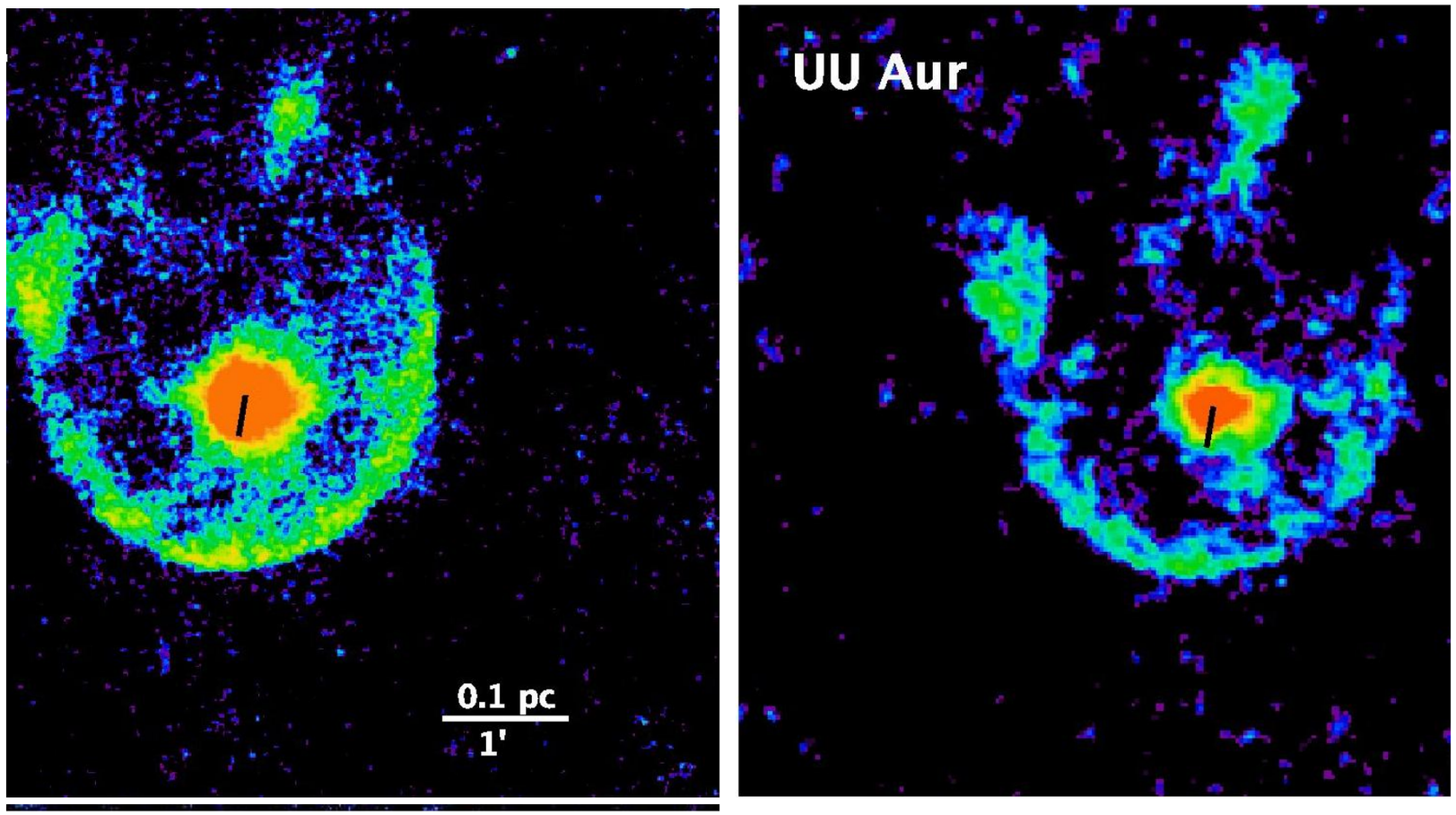
Villaver et al. (2003)




Ramos-García & Philips (2009)



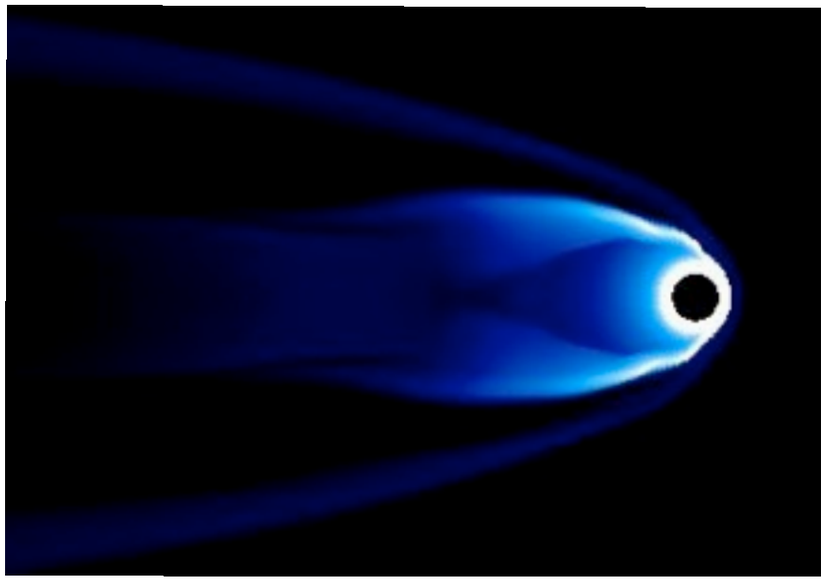



Cox et al. (2011)

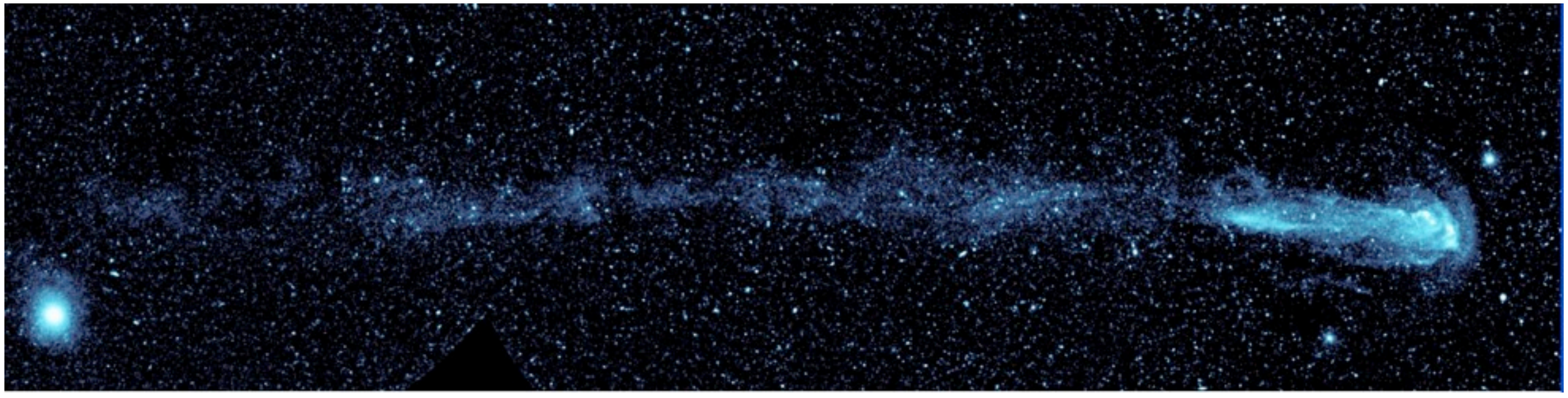
# Other observed examples:

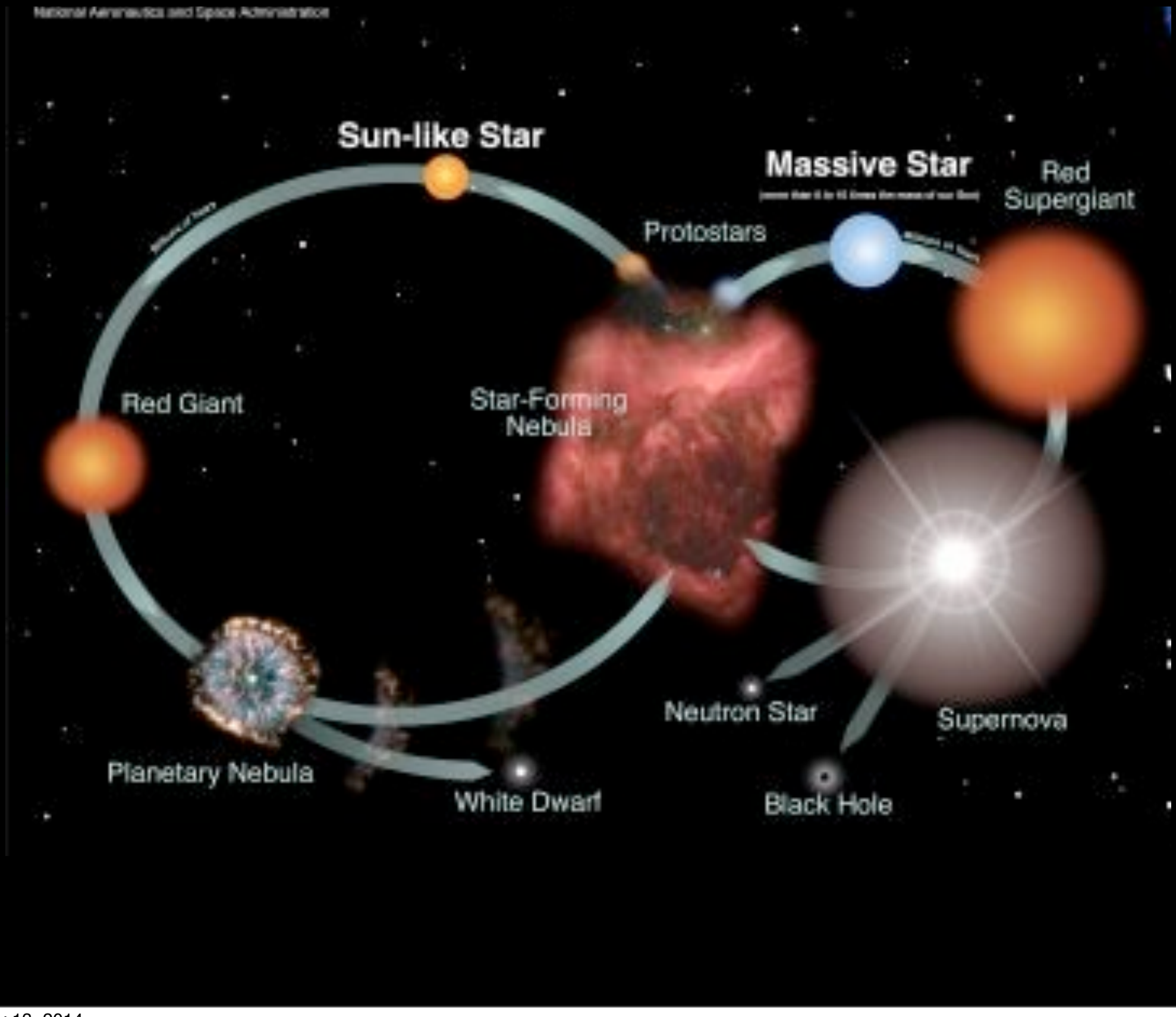
Libert et al. (2008, 2009, 2010); Matthews & Reid (2007); Ueta et al. (2010); Jorissen et al. (2011)

Martin et al. (2007)



Villaver et al. (2012)

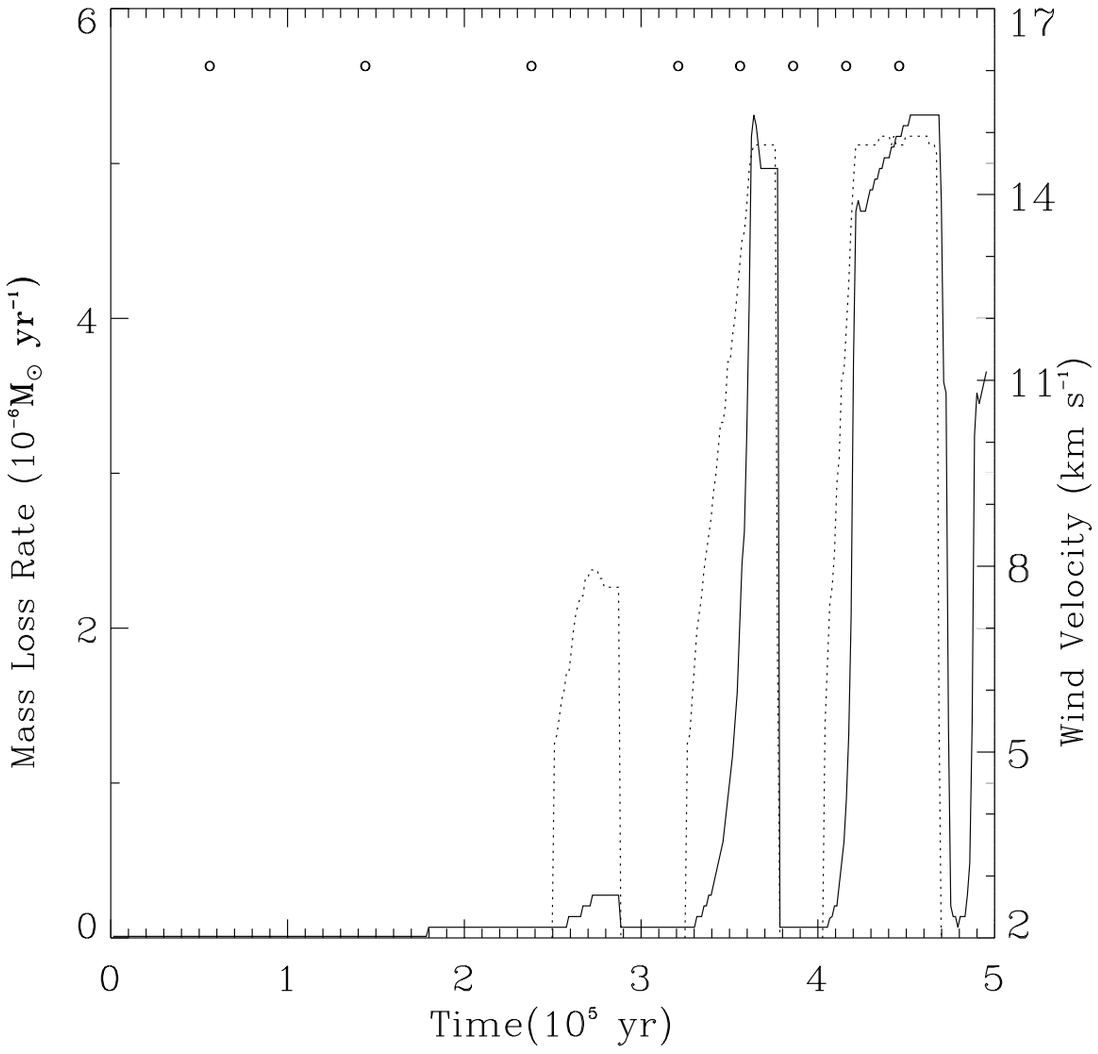


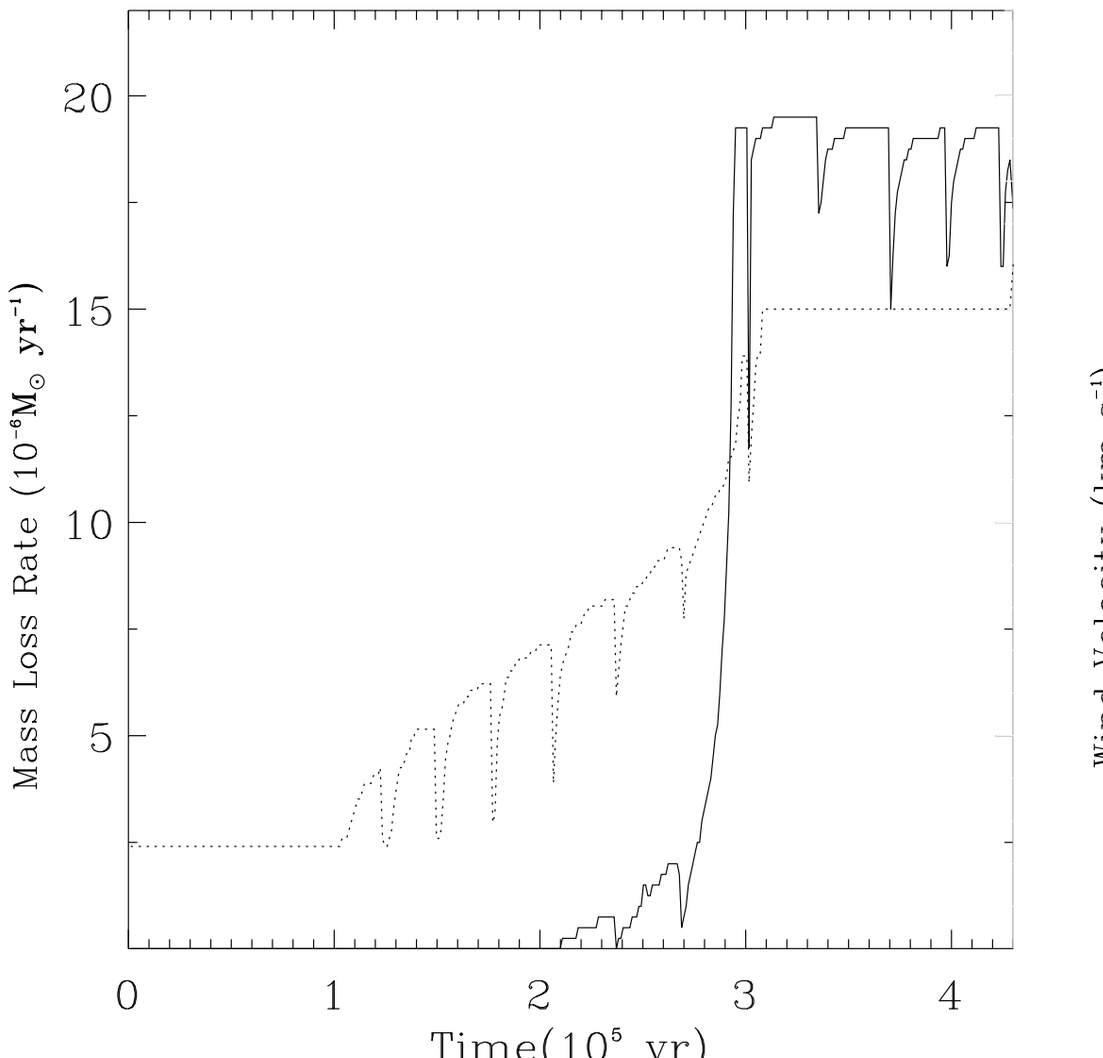

National Aeronautics and Space Administration
Sun-like Star
Massive Star
Red Supergiant
Protostars
Red Giant
Star-Forming Nebula
Neutron Star
Supernova
Planetary Nebula
White Dwarf
Black Hole

# The Ingredients:

1. Stellar evolution

# The Star




## AGB Wind:

## left 1M⊙ right 3.5 M⊙

Vassiliadis & Wood (1993)

# The Ingredients:

2. Stellar dynamics:

systemic velocities in the Galaxy: 0- 150 km/s

Disk

Circular orbits

v~10-40 kms$^{-1}$

Bulge

*v > 100 km s$^{-1}$

Halo

*Random orbits in 3D

*v~85-100 km s$^{-1}$

# The Ingredients:

## 3. ISM conditions

# THE ISM CONDITIONS

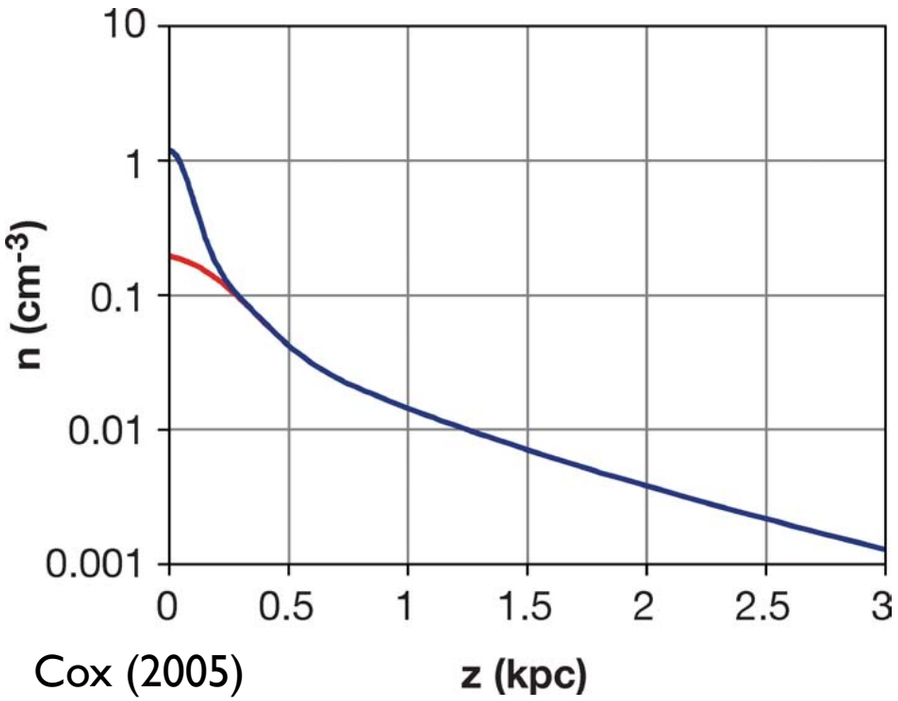
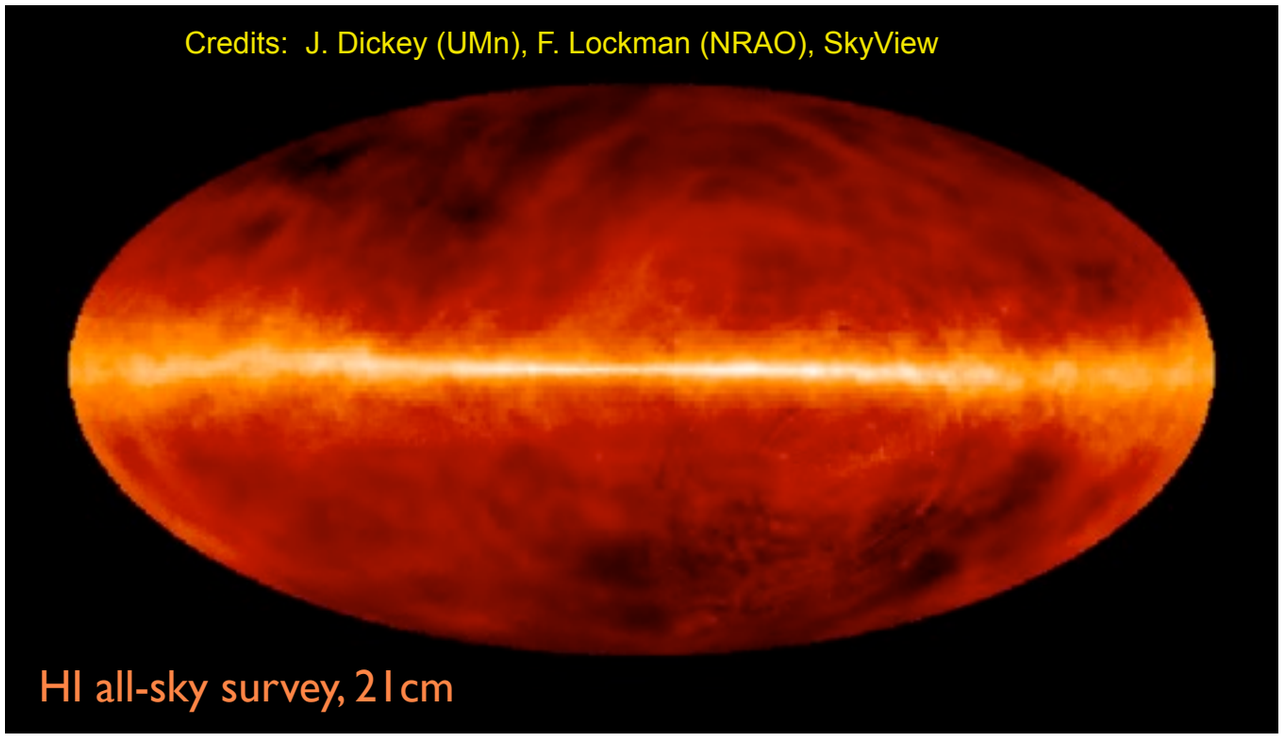



**Figure 1** The distribution of interstellar hydrogen density above the Galactic Plane. The total is shown in *blue*, the warm diffuse component in *red*.

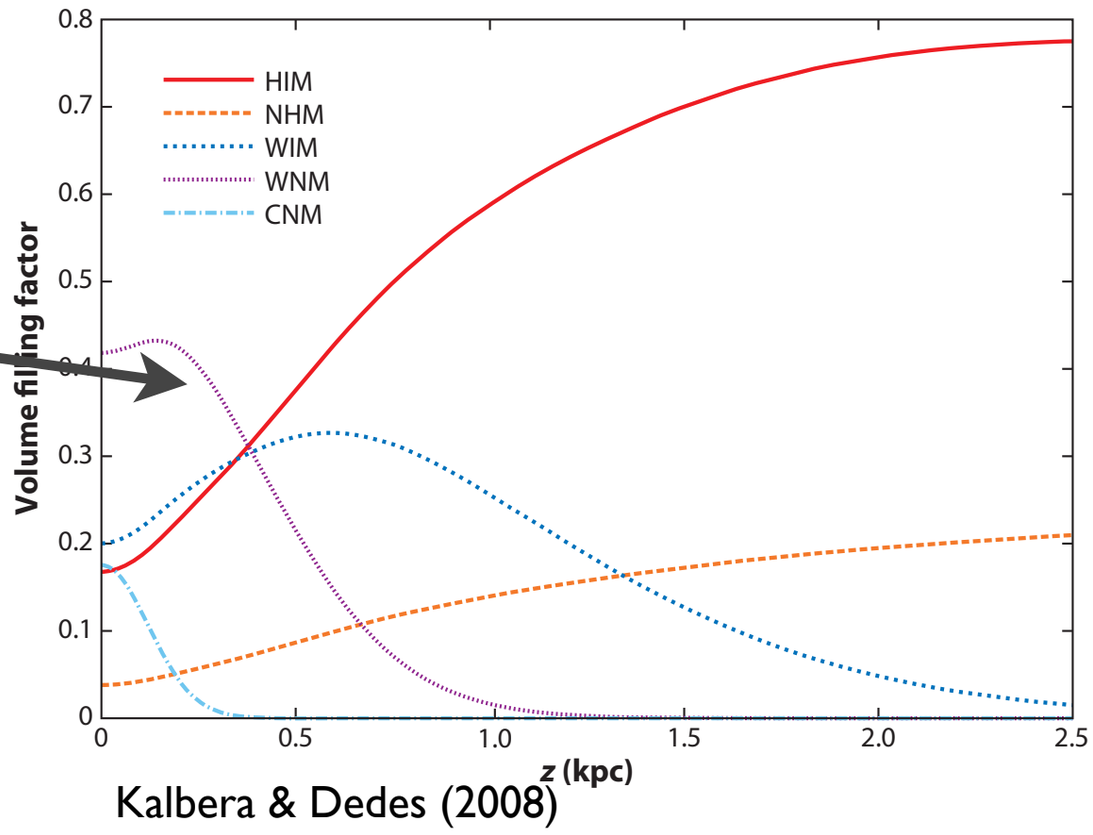



cold HI: $0.57 * 0.7 \exp[-(z/127\,\mathrm{pc})^2]$

warm HIa: $0.57 * 0.18 \exp[-(z/318\,\mathrm{pc})^2]$

warm HIb: $0.57 * 0.11 \exp(-|z|/403\,\mathrm{pc})$

diffuse HII: $0.025 \exp(-|z|/1000\,\mathrm{pc})$.



# The Ingredients:

3. Stellar Mass

....what else.....?

We have a 4th ingredient:

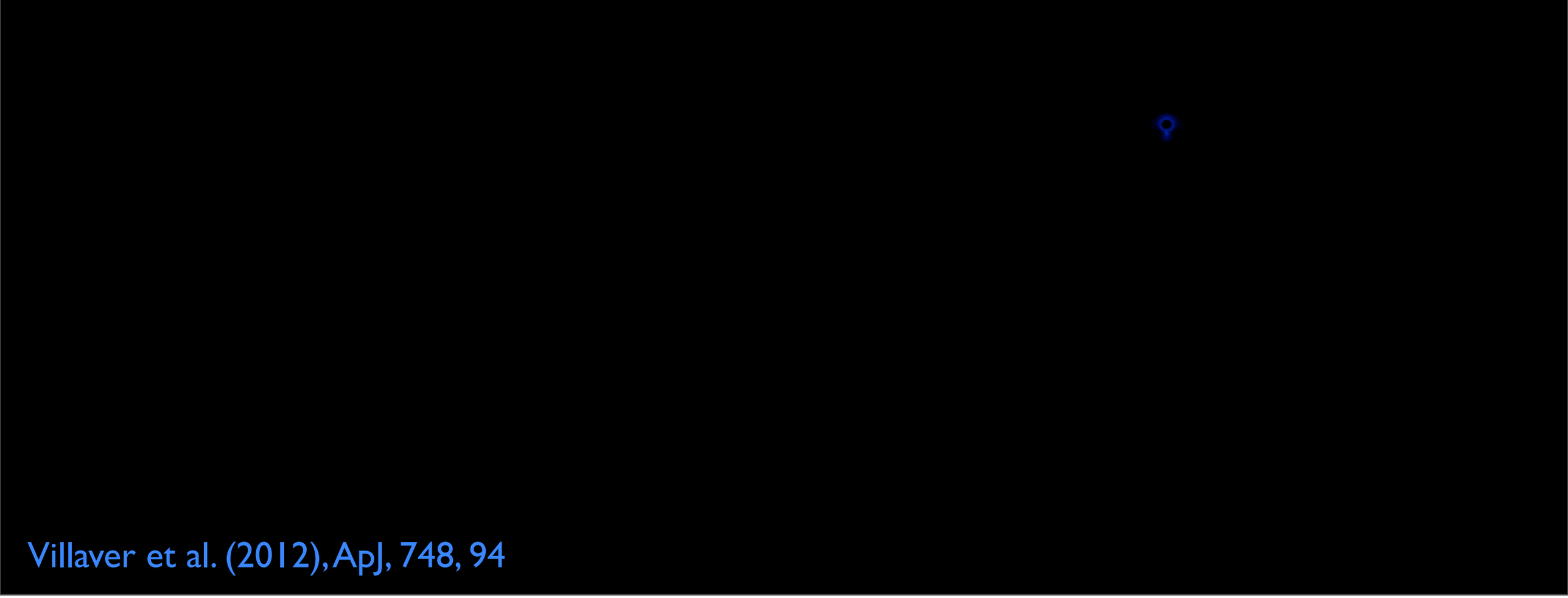
.....we added a Galactic Magnetic Field.

6 microgauss (Beck 2013).

# Low Velocity Interaction: V = 10 km/s

$n = 0.1\ cm^{-3}$

$n = 1\ cm^{-3}$



Villaver et al. (2012), ApJ, 748, 94

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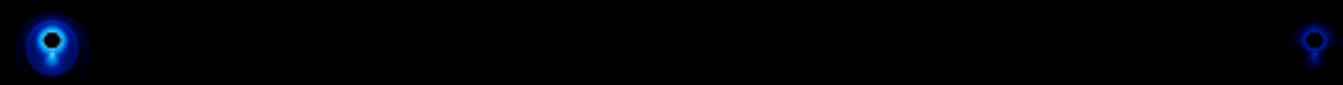


Villaver et al. (2012), ApJ, 748, 94

# High Velocity Interaction $V = 100$ km s$^{-1}$

$n = 0.01$ cm$^{-3}$

$n = 0.1$ cm$^{-3}$

Villaver et al. (2012), ApJ, 748, 94

t

v

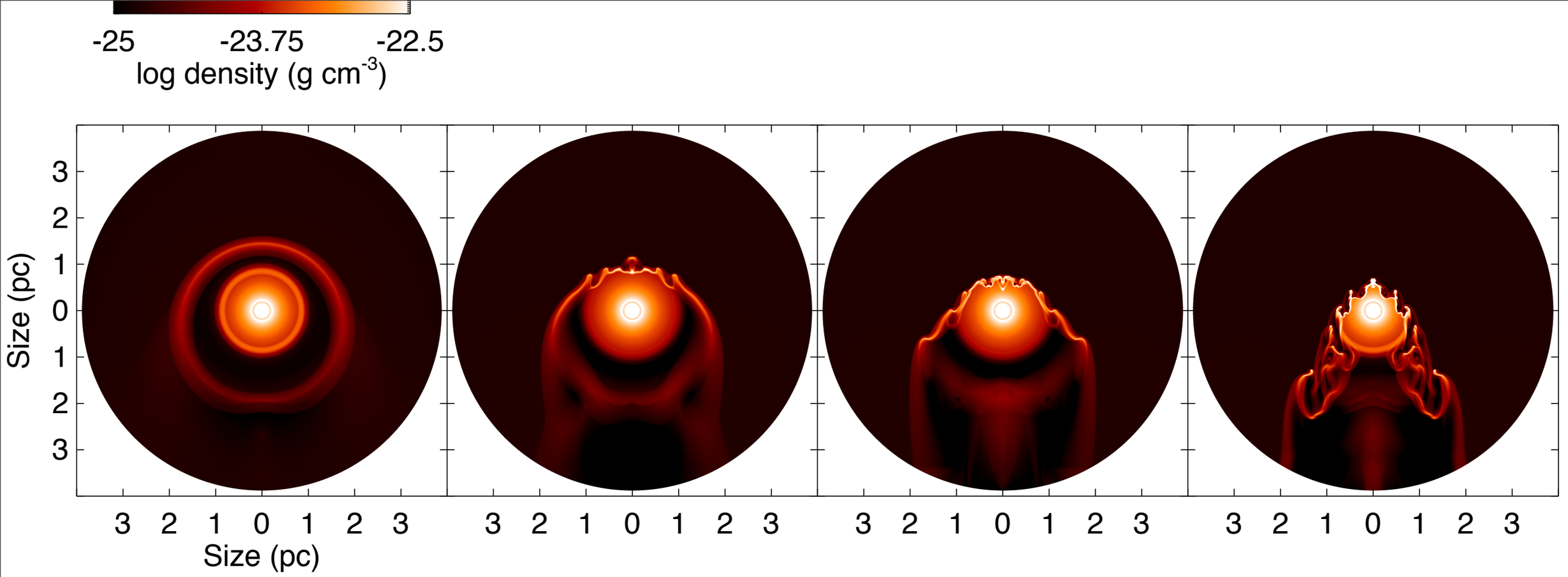
Villaver et al. (2012), ApJ, 748, 94

1 $M_\odot$

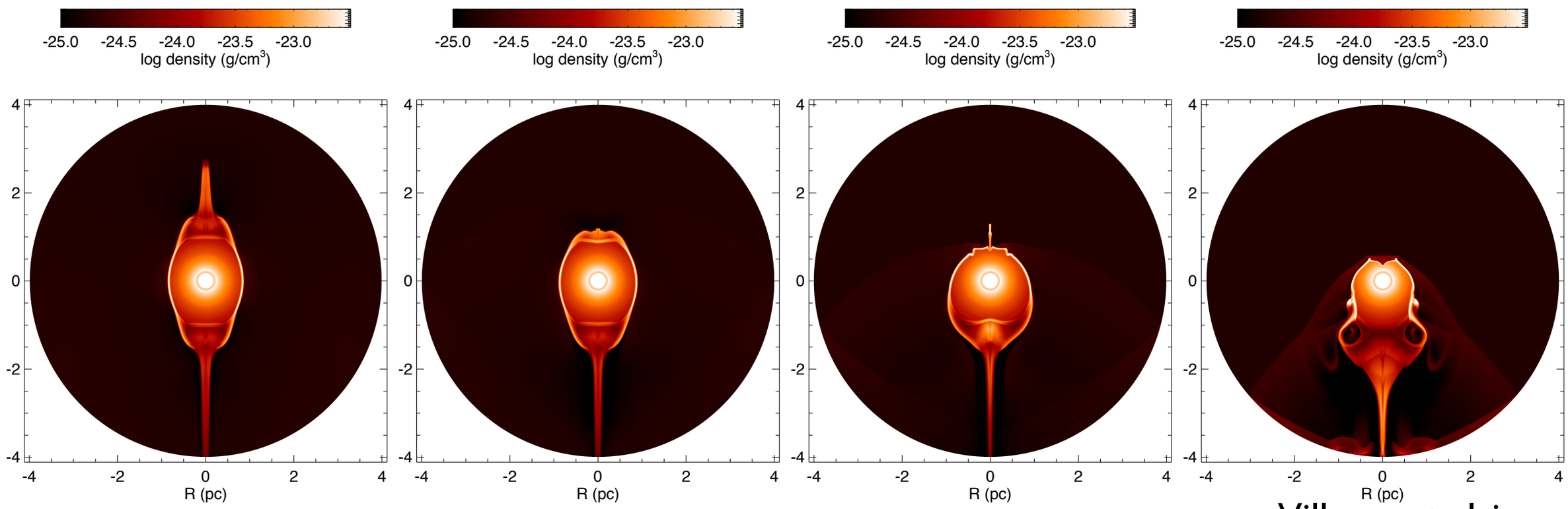
3.5 $M_\odot$

$n = 0.1\ cm^{-3}\ v = 50\ km\ s^{-1}$

Villaver et al. (2012), ApJ, 748, 94




B = 6 microgauss




Villaver et al. in prep.

★Environment has an important effect in PNe shaping

★Low velocities can form bow-shocks

★Velocity ---> instabilities but density too!

★High stellar mass no imprint of interaction at the end of the AGB

★Galactic Magnetic Field can mimic a subsonic interaction