Institute of
Space Sciences

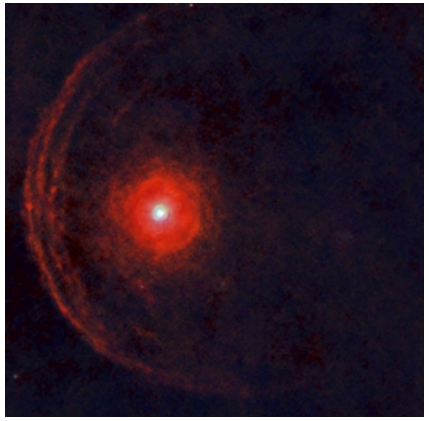
EXCELENCIA
MARÍA
DE MAEZTU

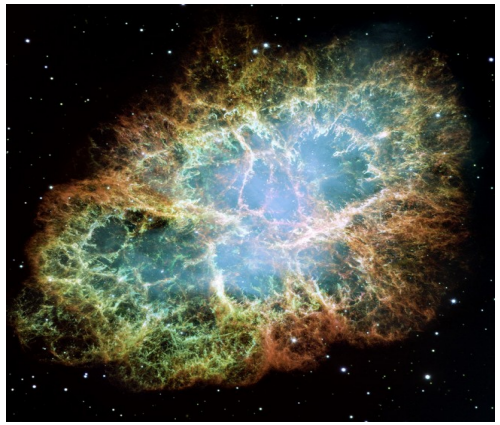
Pulsar wind nebulae meeting the circumstellar medium of their progenitors

Meyer D. M.-A., Meliani Z., Torres D. F.

Massive star circumstellar evolution

Main-sequence → Supergiant → Supernova → Pulsar



Stellar wind → Ejecta → Leptions

So far neglected in pulsar wind litterature

- Credits : NASA (Spitzer, Herschel, HST), ESO.

Models of pulsar wind nebulae... so far without stellar wind !

MULTIMESSENGER ASTROPHYSICS
COSMIC RAYS - COMPACT OBJECTS - RELATIVISTIC ENVIRONMENTS
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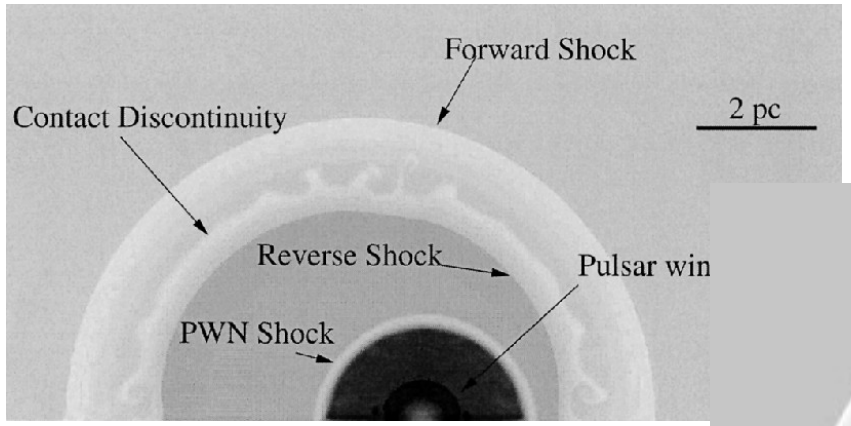
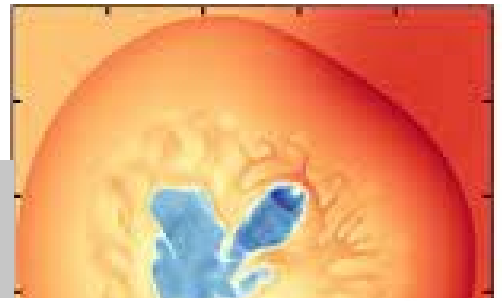
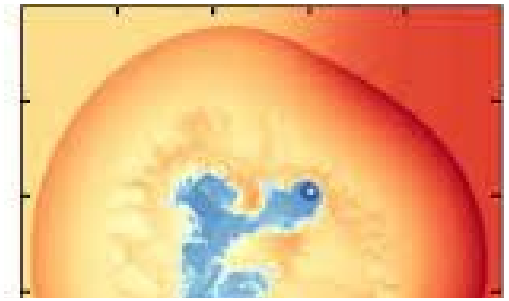
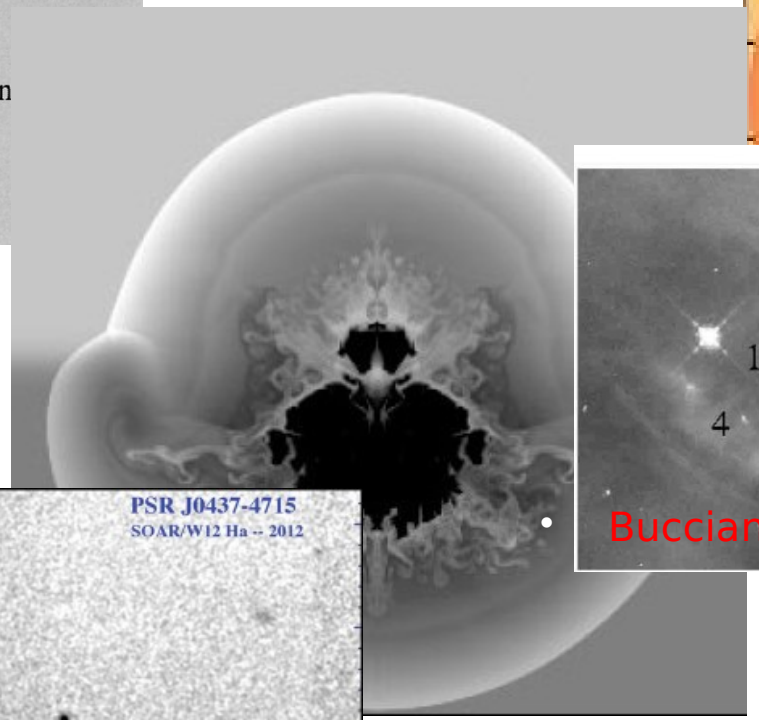


van der Swaluw (2004)

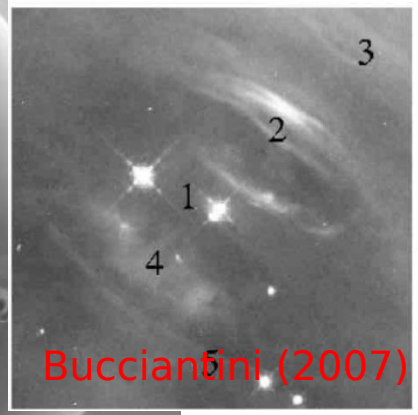
Kolb et al. (2017)



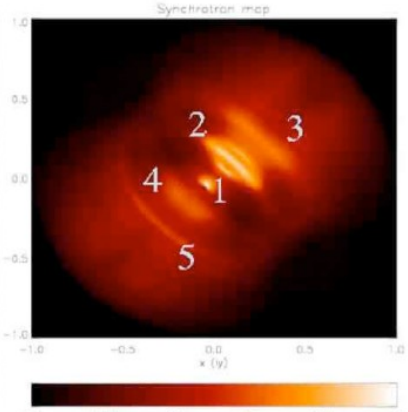


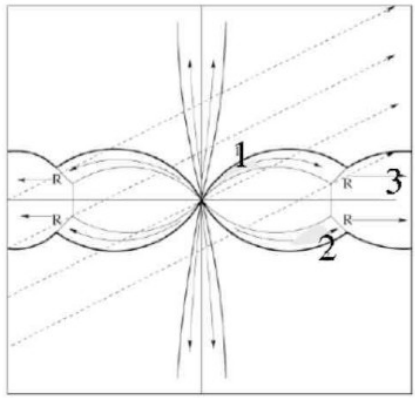


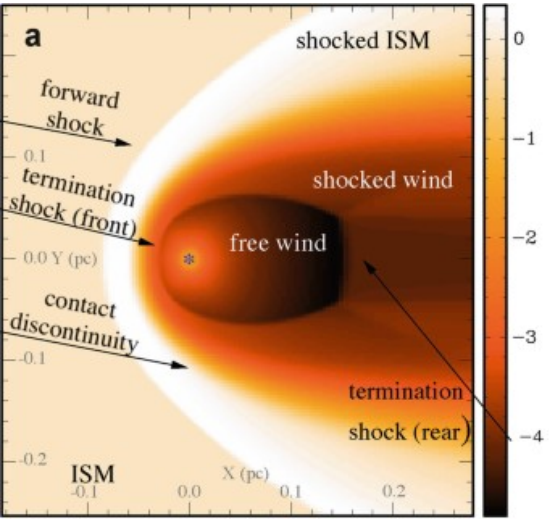
Blondin et al. (2001)

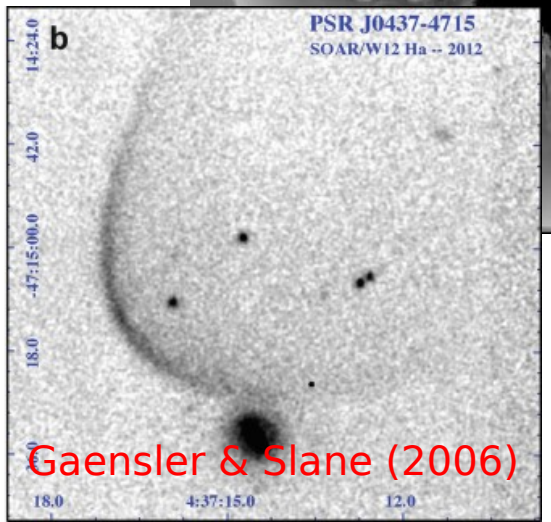


Buccantini (2007)

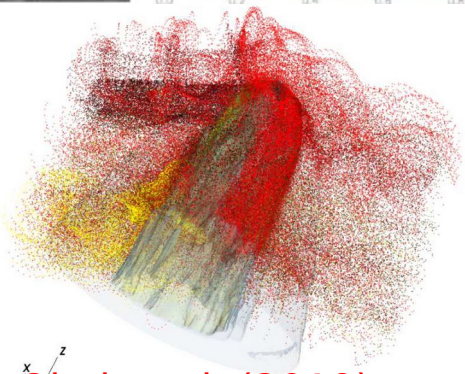


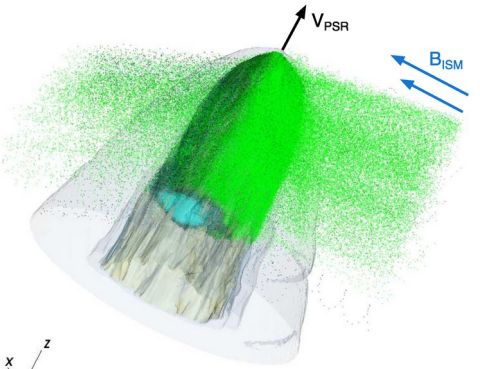






Gaensler & Slane (2006)





Olmi et al. (2019)

What we want to do ?

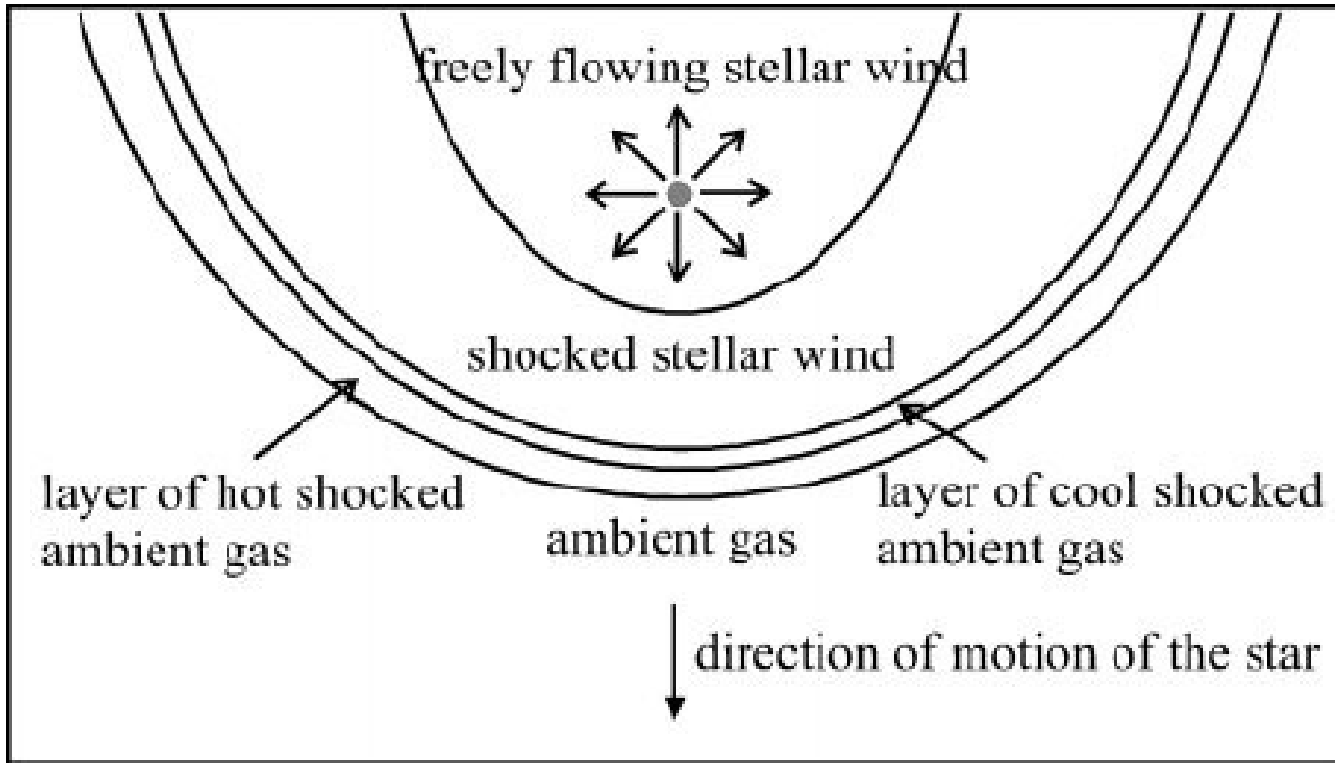
Interstellar medium

Stellar wind

Supernova ejecta

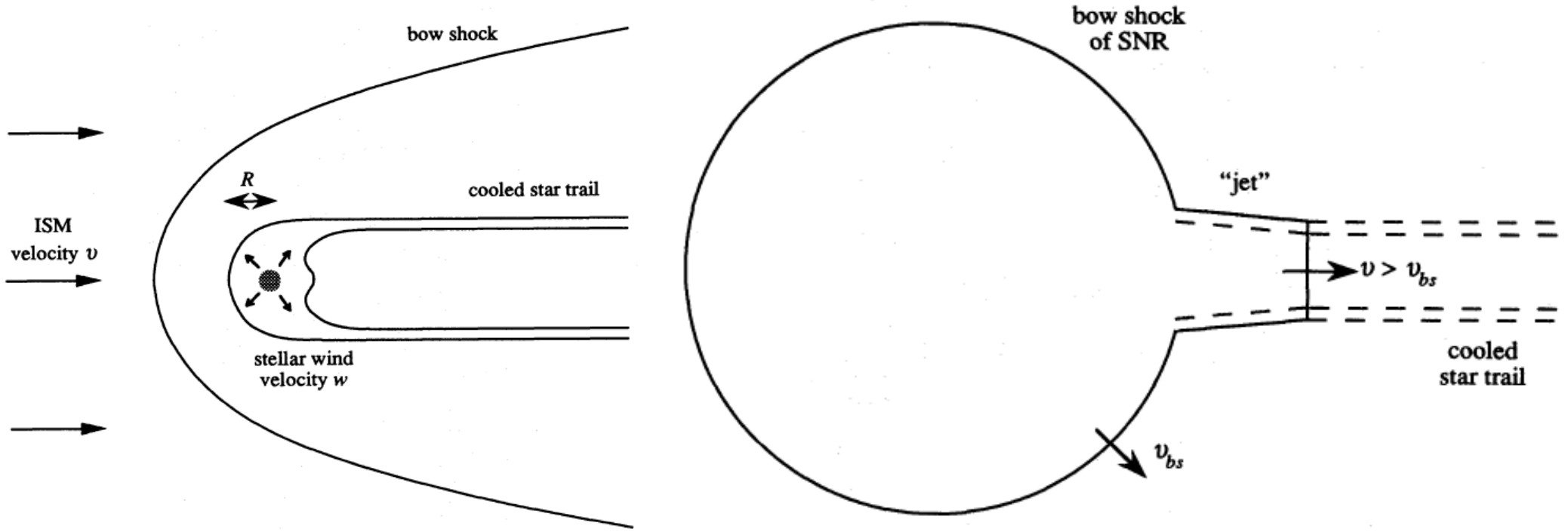
Pulsar wind

Stellar wind bow shocks



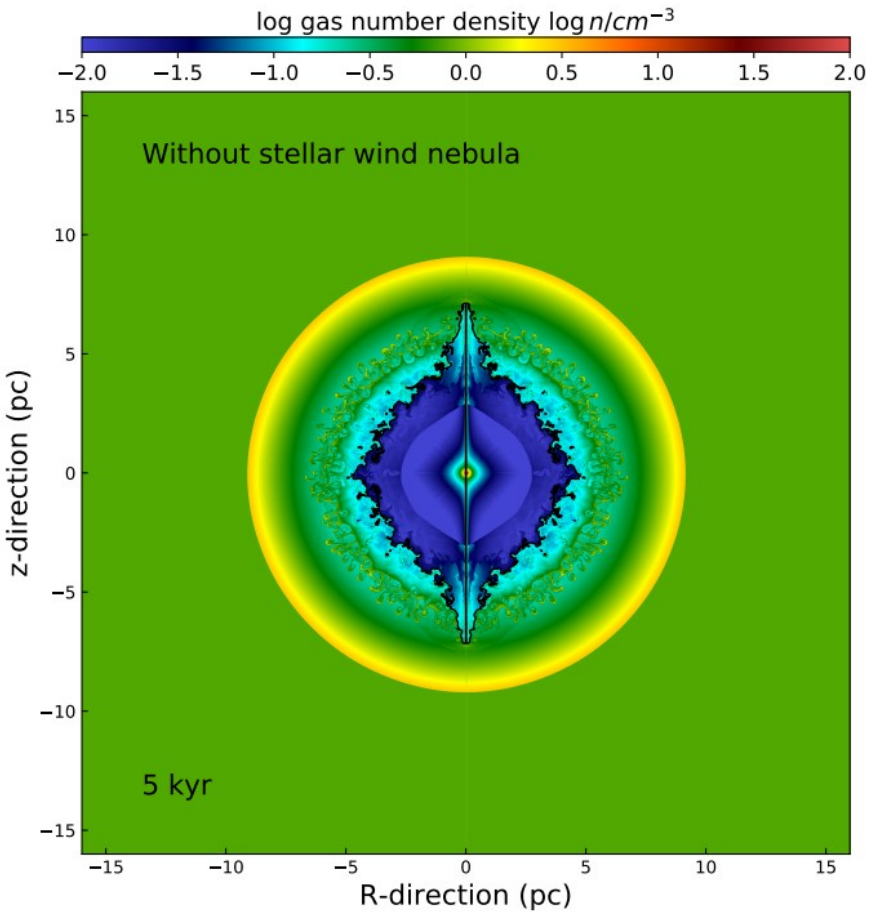
30 % of massive stars are moving fast and will die into their own bow shock

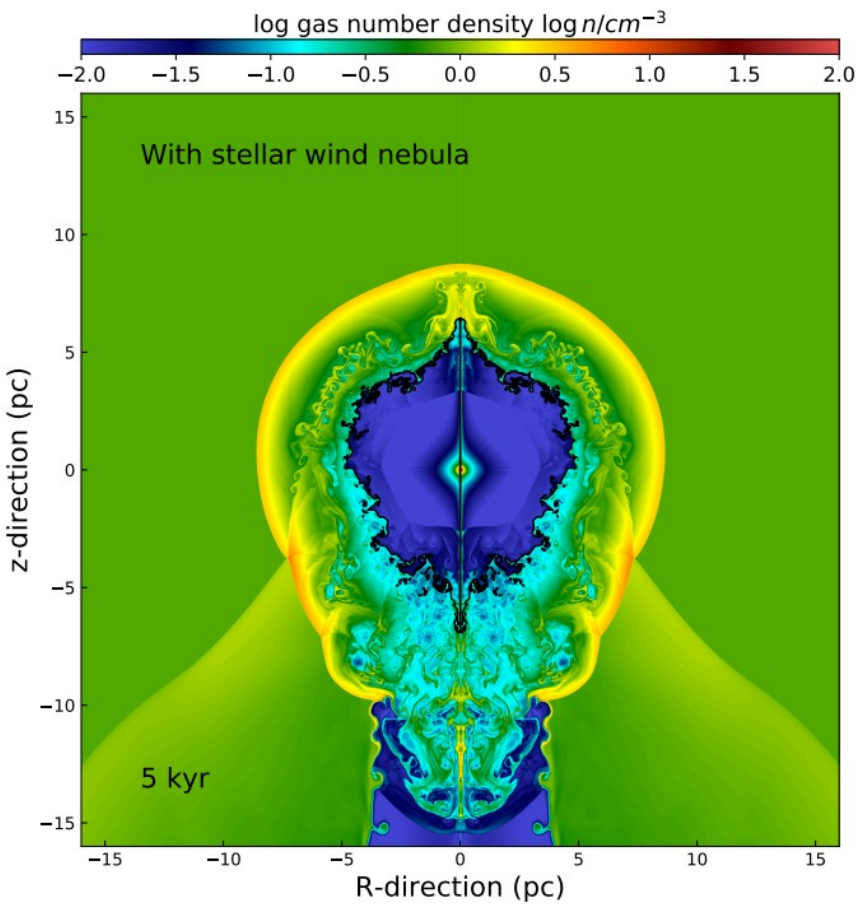
Runaway massive star die in their own bow shock



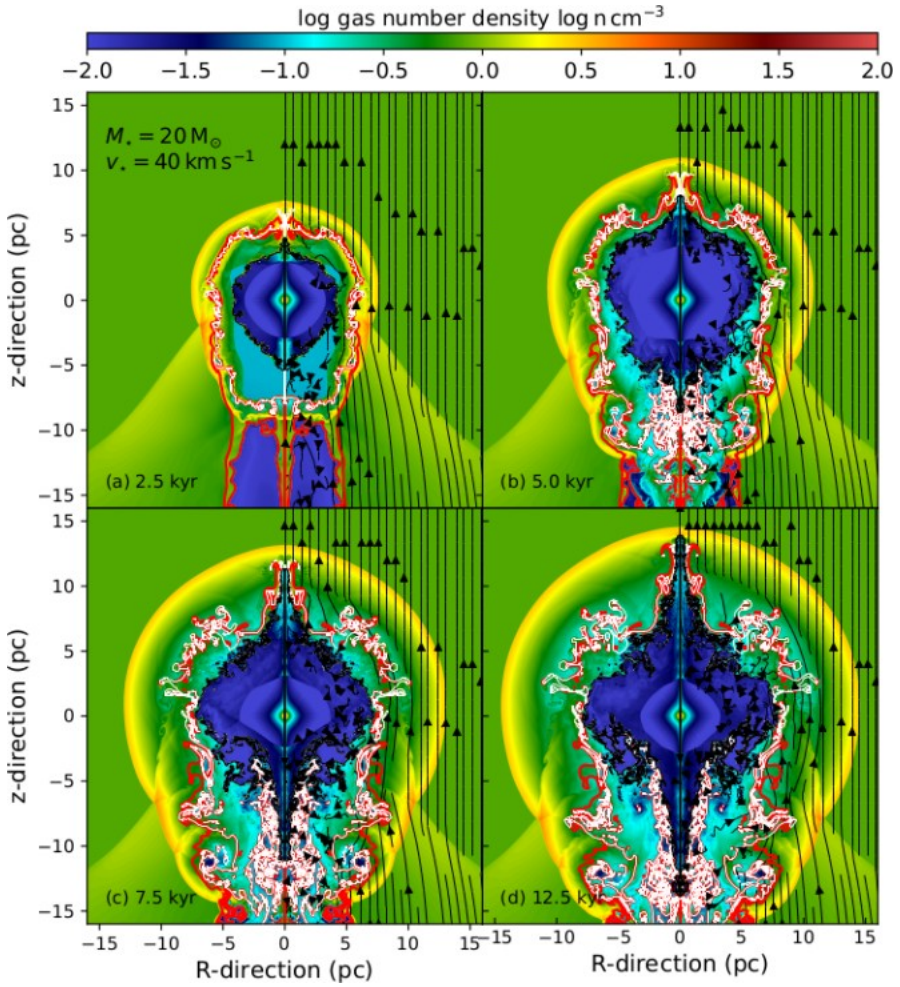
Cox et al. (1991)

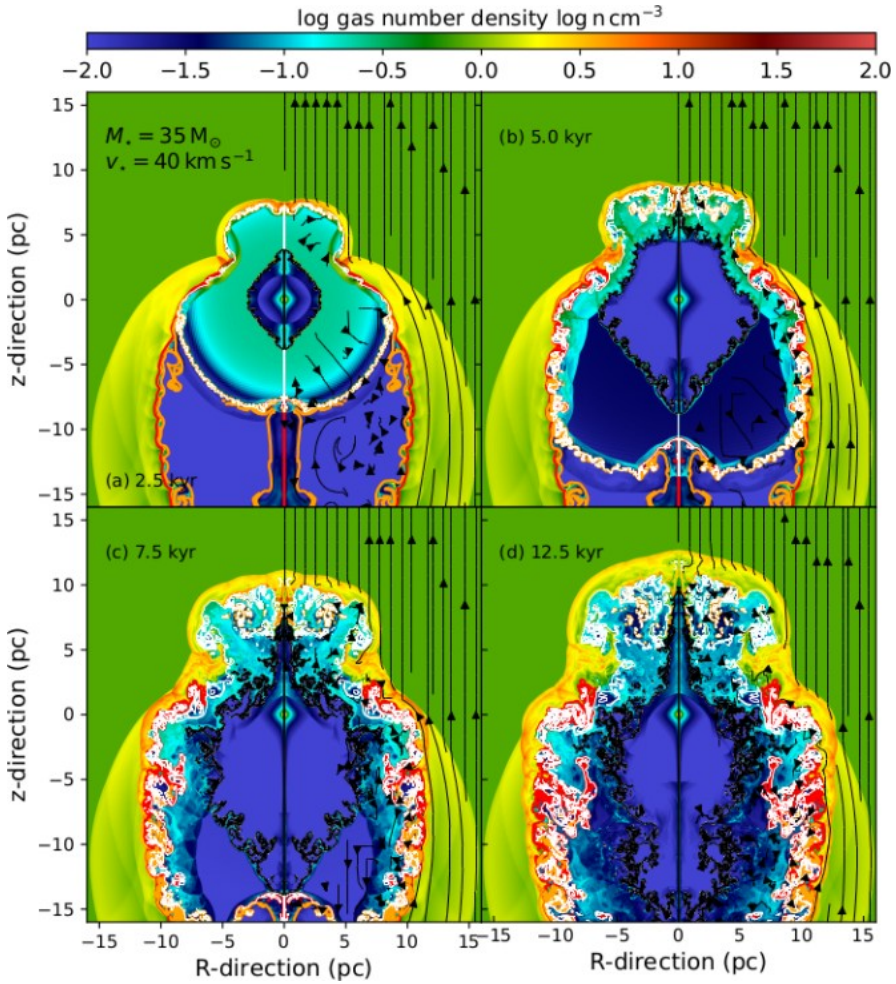
Asymmetric remnant with pulsar wind nebulae





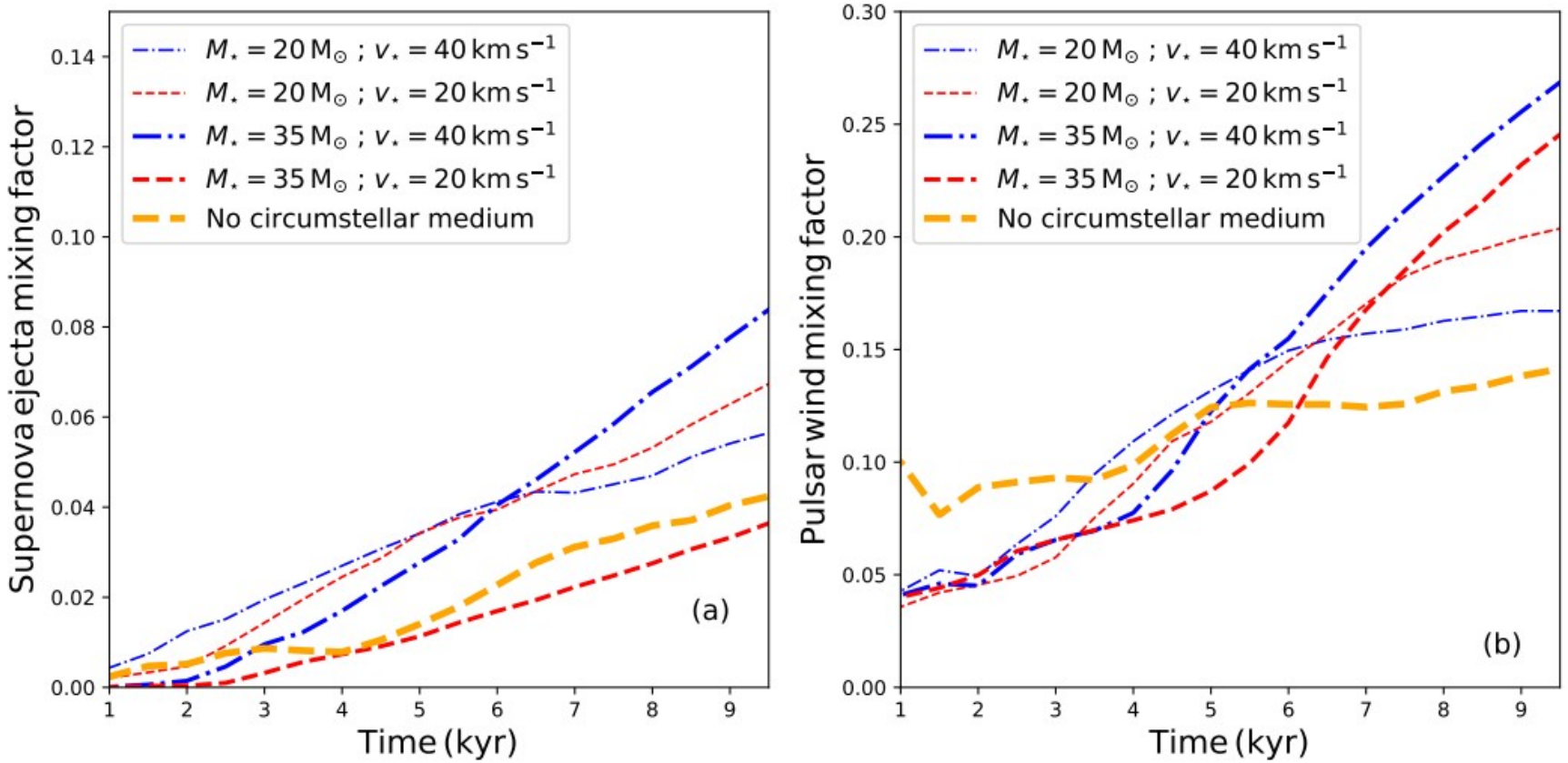
Effect of progenitor bulk motion

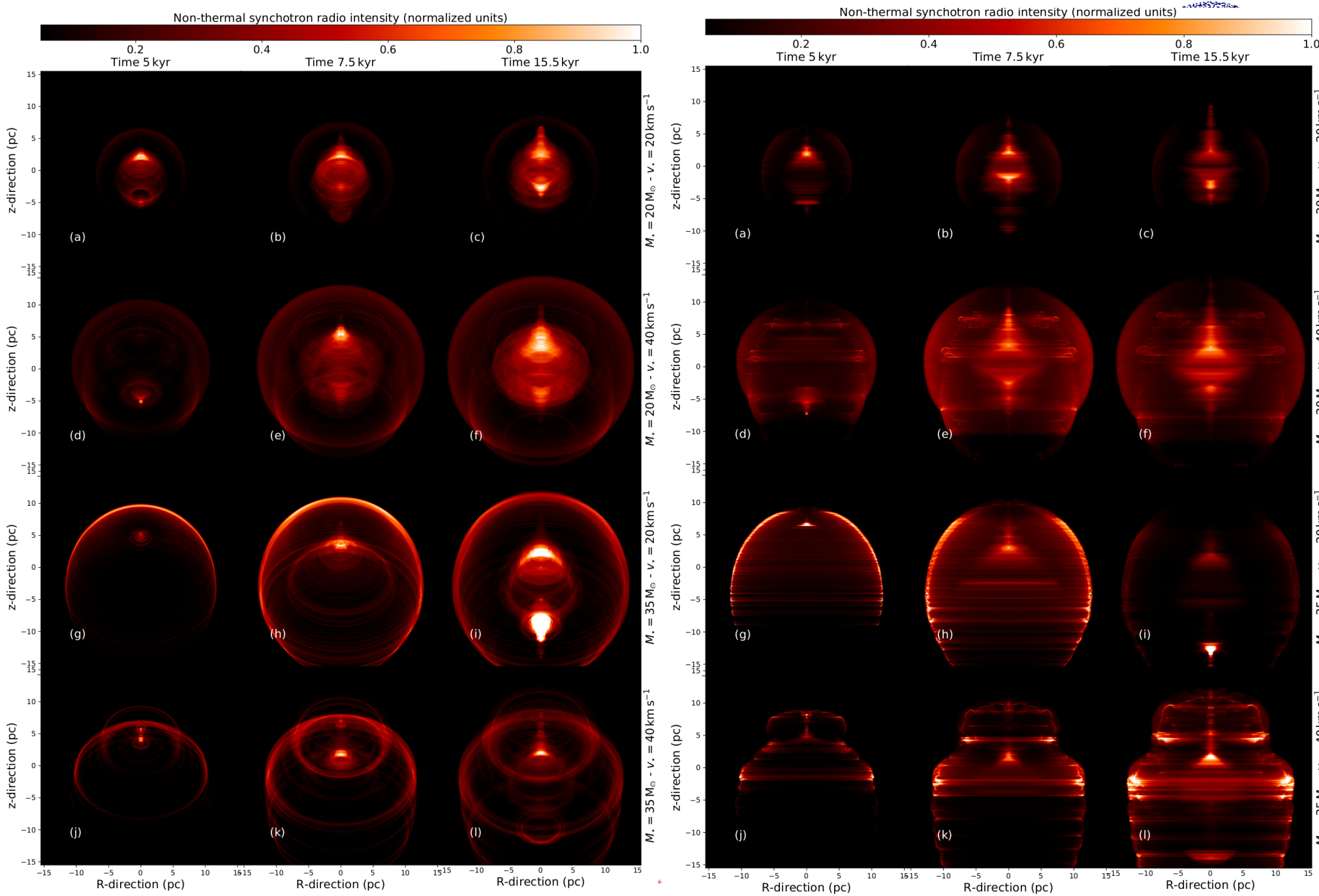




- Plerion of 20 Mo progenitor stars

Effect of circumstellar medium on the mixing of supernova ejecta





Non-thermal synchotron radio intensity (normalized units)
0.2
0.4
0.6
0.8
1.0
Time 5 kyr
Time 7.5 kyr
Time 15.5 kyr
z-direction (pc)
R-direction (pc)
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
$M_\star = 20\,M_\odot$ - $v_\star = 20\,km\,s^{-1}$
$M_\star = 20\,M_\odot$ - $v_\star = 40\,km\,s^{-1}$
$M_\star = 35\,M_\odot$ - $v_\star = 20\,km\,s^{-1}$
$M_\star = 35\,M_\odot$ - $v_\star = 40\,km\,s^{-1}$

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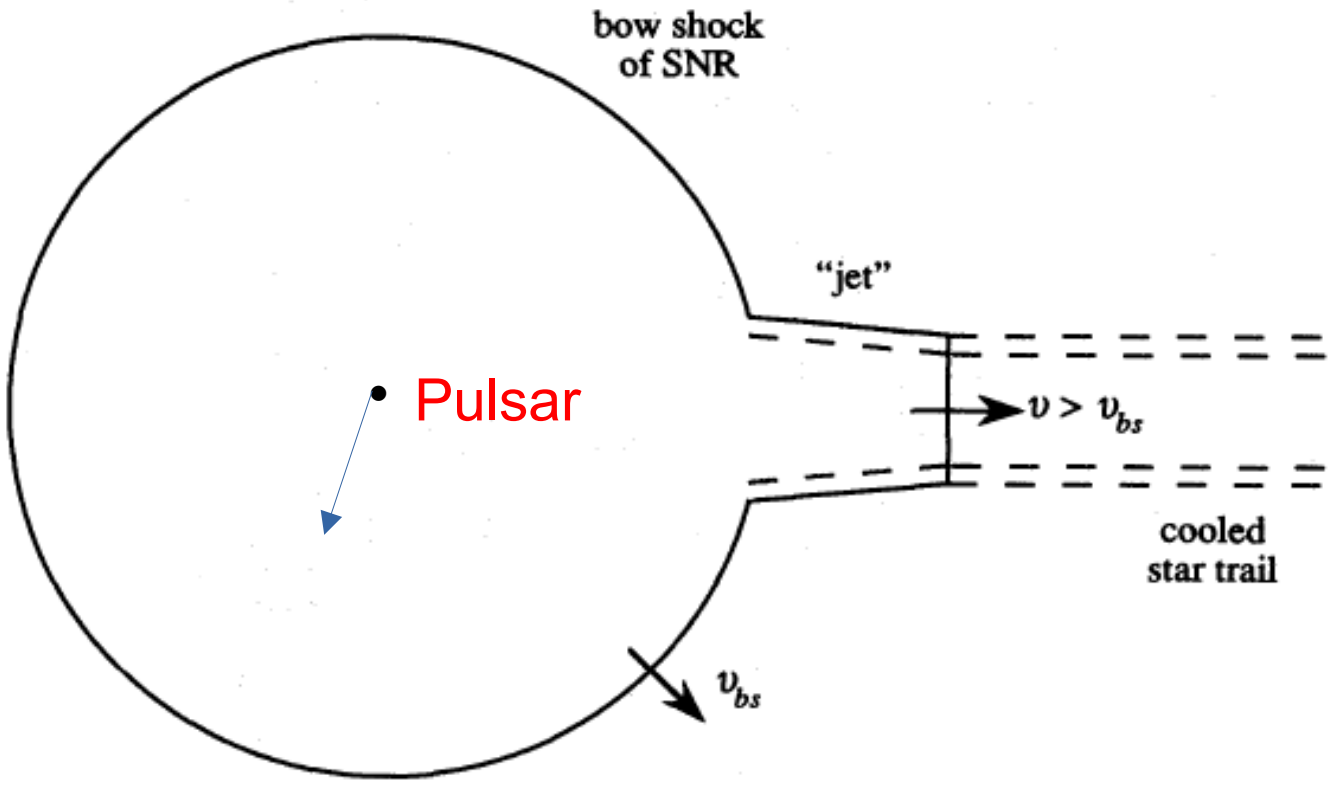
Synchrotron radio emission maps

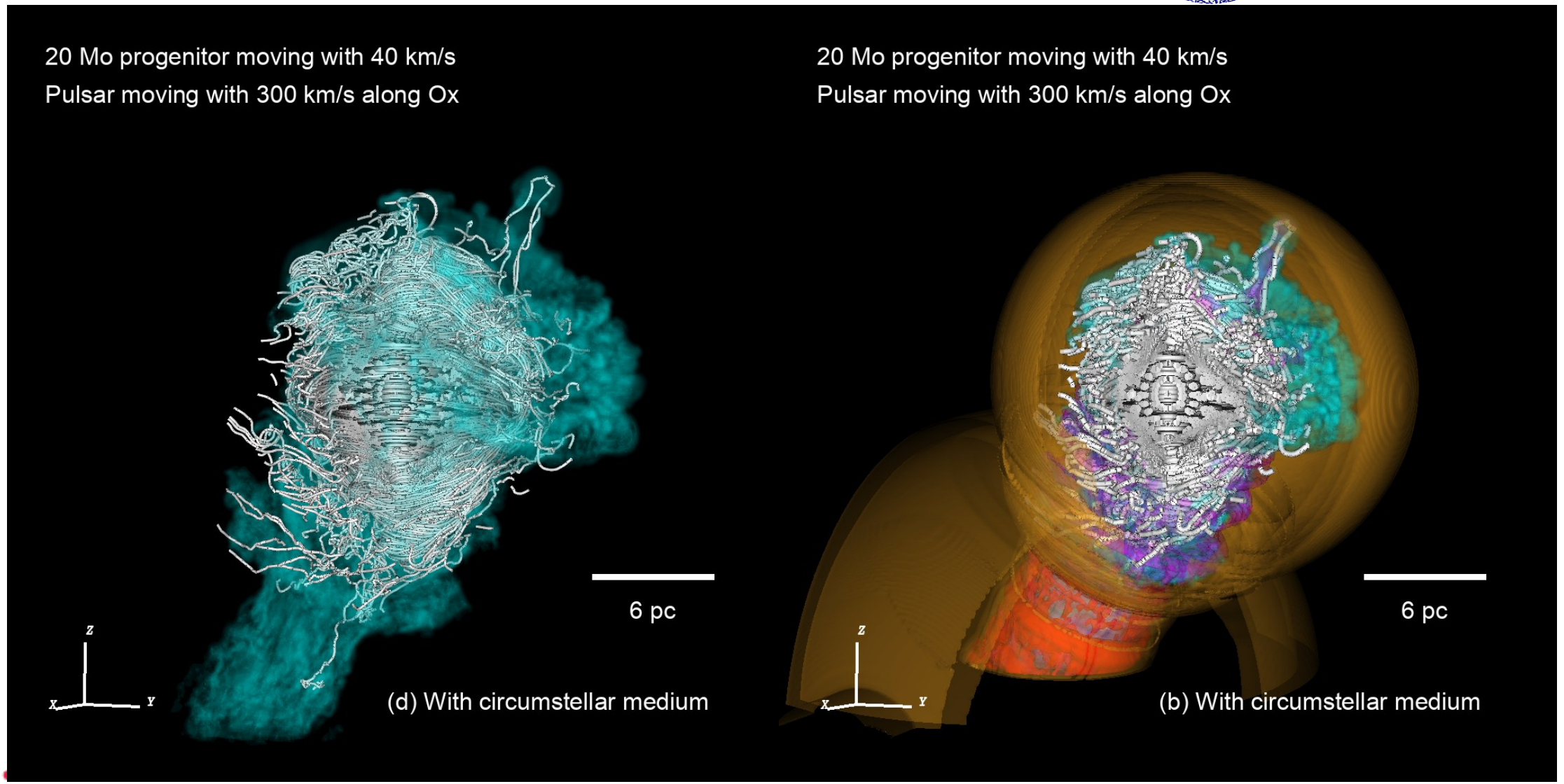
ICREA CSIC IEEC

Meyer D. M.-A.

Next: runaway pulsar wind nebula



Next: 3D MHD models with pulsar motion inside of the remnant



Take home message

The circumstellar medium of massive (runaway) star is a governing parameter in the morphology, distribution and mixing of materials in plerion.

eprint arXiv:2409.15829

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EXCELENCIA MARÍA DE MAEZTU

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