EMPIRICAL DIAGNOSTICS OF PROTOPLANETARY DISC WINDS

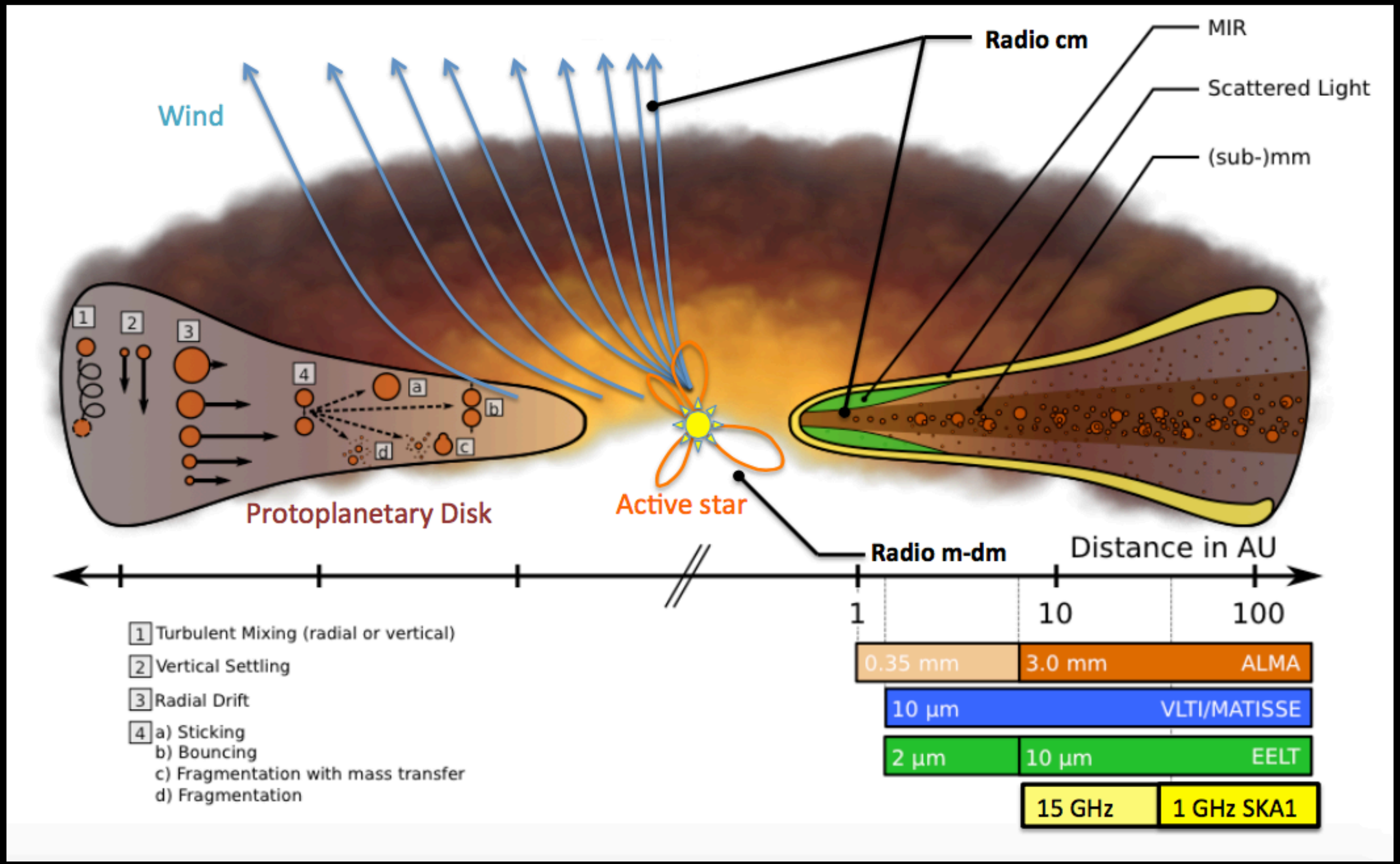
GIULIA BALLABIO & RICHARD ALEXANDER
UNIVERSITY OF LEICESTER

DUST BUSTERS

UNIVERSITY OF LEICESTER

DISC-USSION - MONASH UNIVERSITY

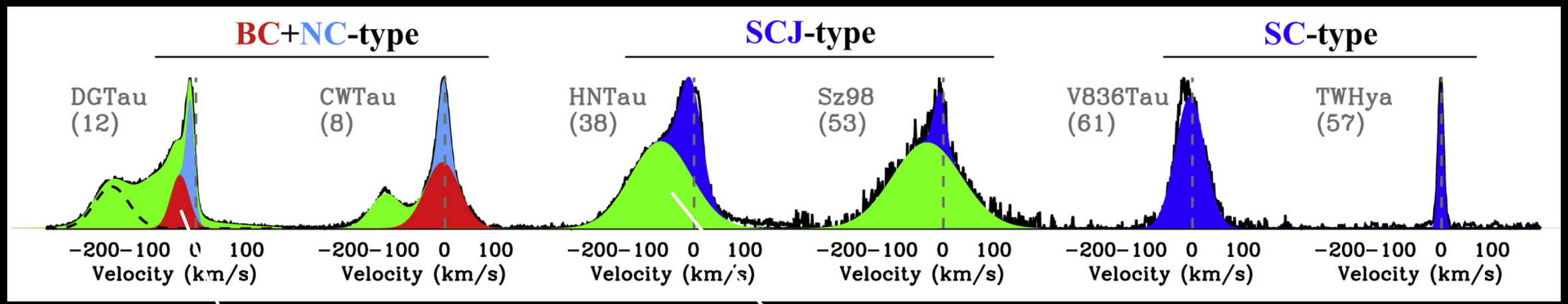
PROTOPLANETARY DISCS



(Testi et al. 2015)

OBSERVATIONS OF WINDS

Traces of winds have been observed:



(Banzatti et al. 2019)

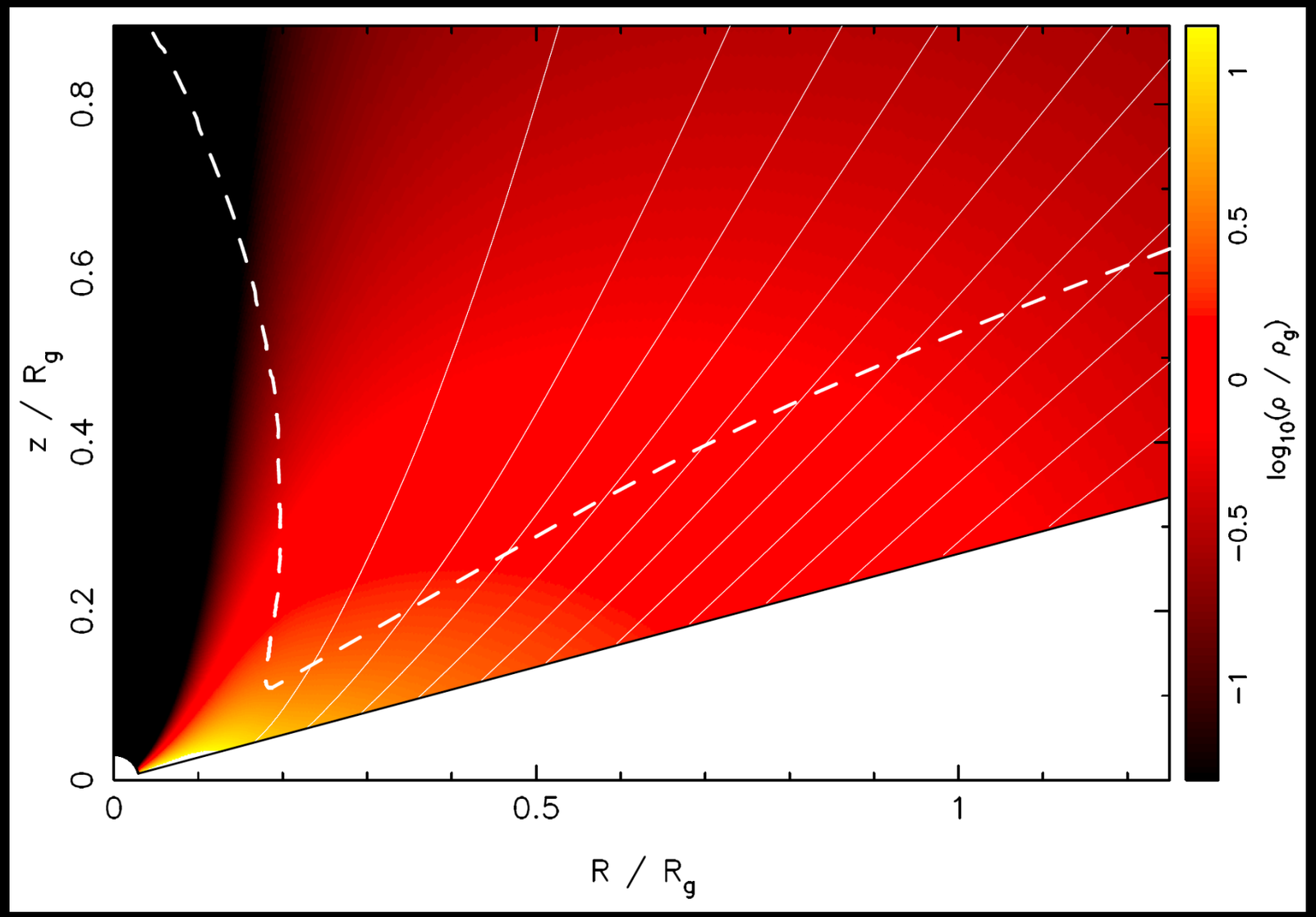
Low Velocity Components:
Thermal winds

High Velocity Components:
Jets collimated by MHD winds

PHOTOEVAPORATION

(Alexander et al. 2014)

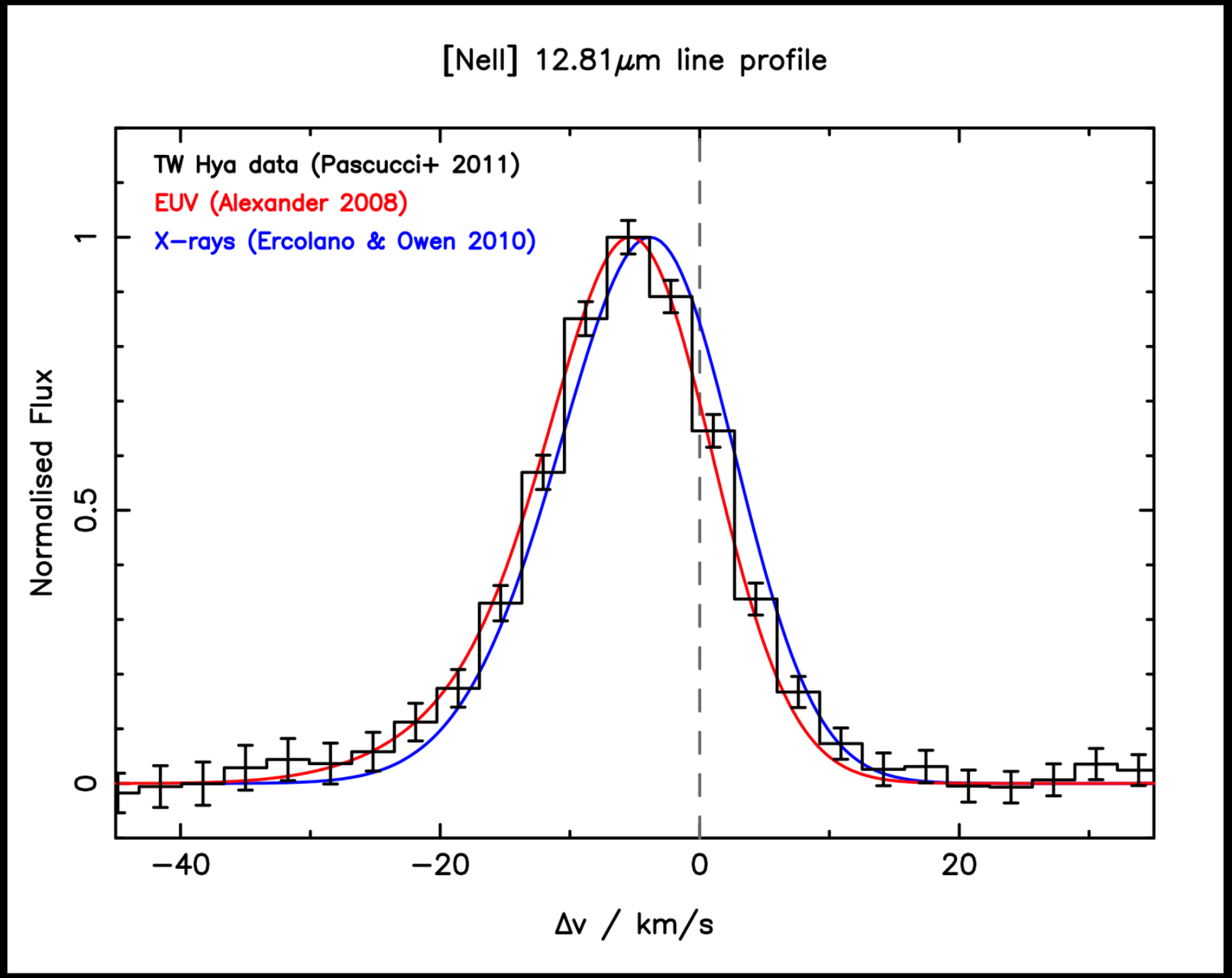
$$R_g = \frac{GM_*}{c_s^2}$$



Outside a critical radius, the hot gas is unbound and flows as a wind (Hollenbach 1994, 2000).

BLUE-SHIFTED LINES

Evident detection of a low velocity thermal wind: blue-shifted [NeII] emission.



(Alexander et al. 2014)

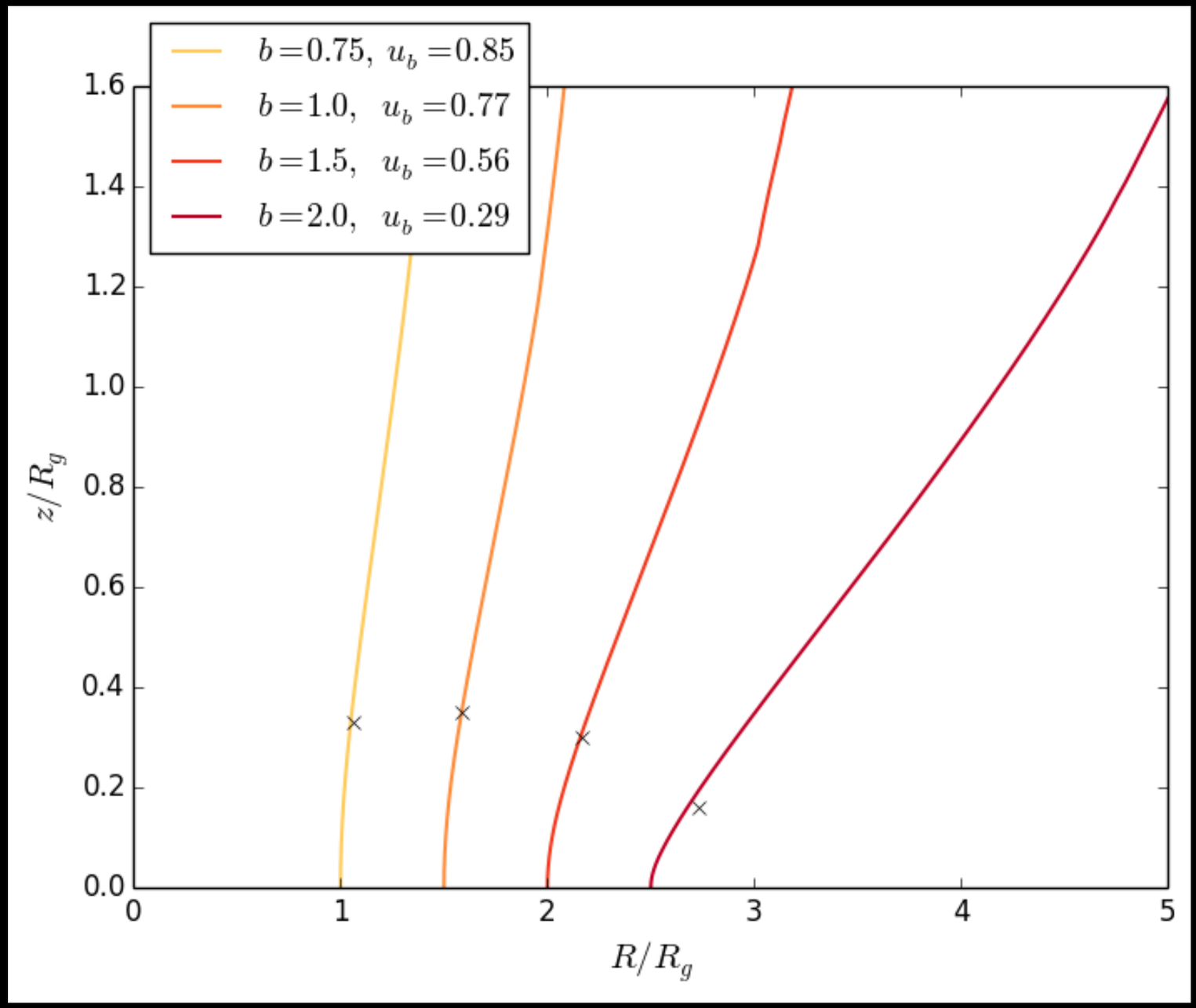
A NEW APPROACH

Axisymmetry + Isothermal wind —> Self-similar solutions

Wind launched with a velocity u_b from a disc where the density at the base is given by

$$\rho_0(R) \propto R^{-b}$$

(Clarke & Alexander 2016)



PARAMETERS SPACE

We build a 3D density and velocity fields and we compute the line profiles.

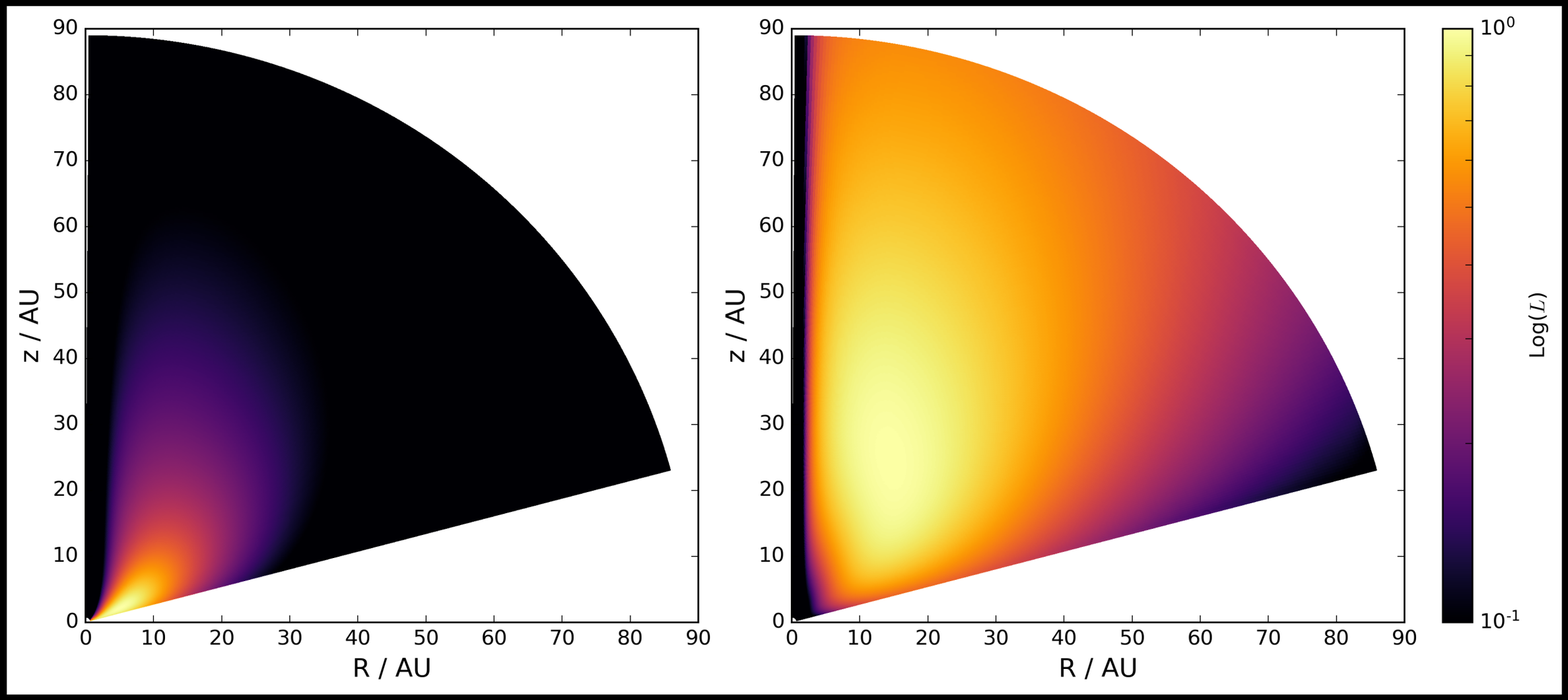
Most significant parameters:

b	R_{in} [R_g]	R_{out} [R_g]	c_s [km/s]	ρ_0 [$M_\odot$/yr]
0.75	0.01	5.0	3.0	10e-10
1.00	0.03	10.0	5.0	10e-9
1.50	0.1		10.0	10e-8

+ different tracers & different disc inclinations

WHERE IS THE EMISSION COMING FROM?

We compute the flux from density and velocity fields.



High critical density

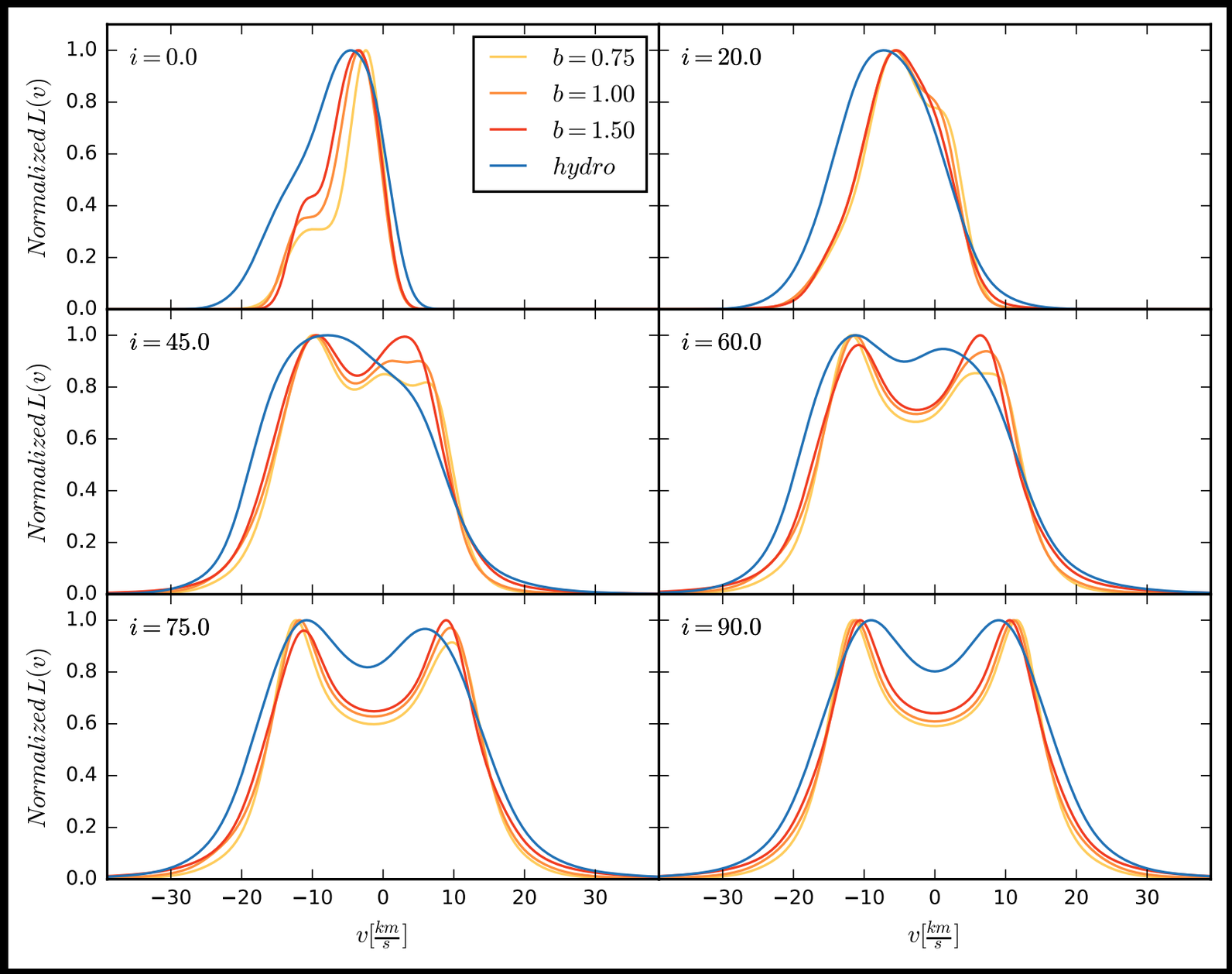
Low critical density

(Ballabio & Alexander in prep.)

LINE PROFILES

We compute the line profiles for the [NeII] emission line.

We can model the blue-shifts, which range from a few to ~10 km/s.

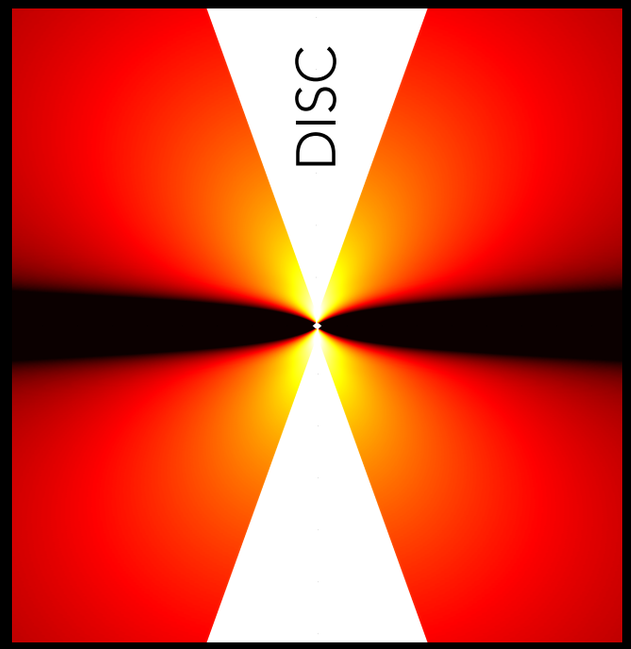


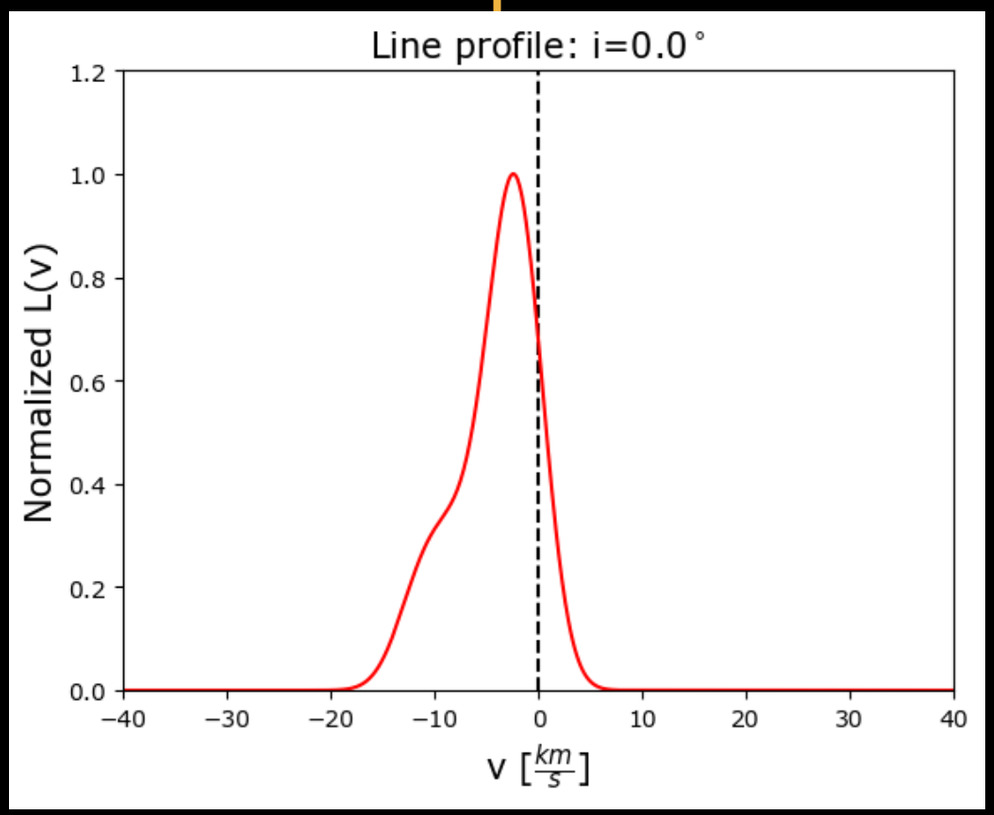
(Hydro data taken from Alexander 2008)

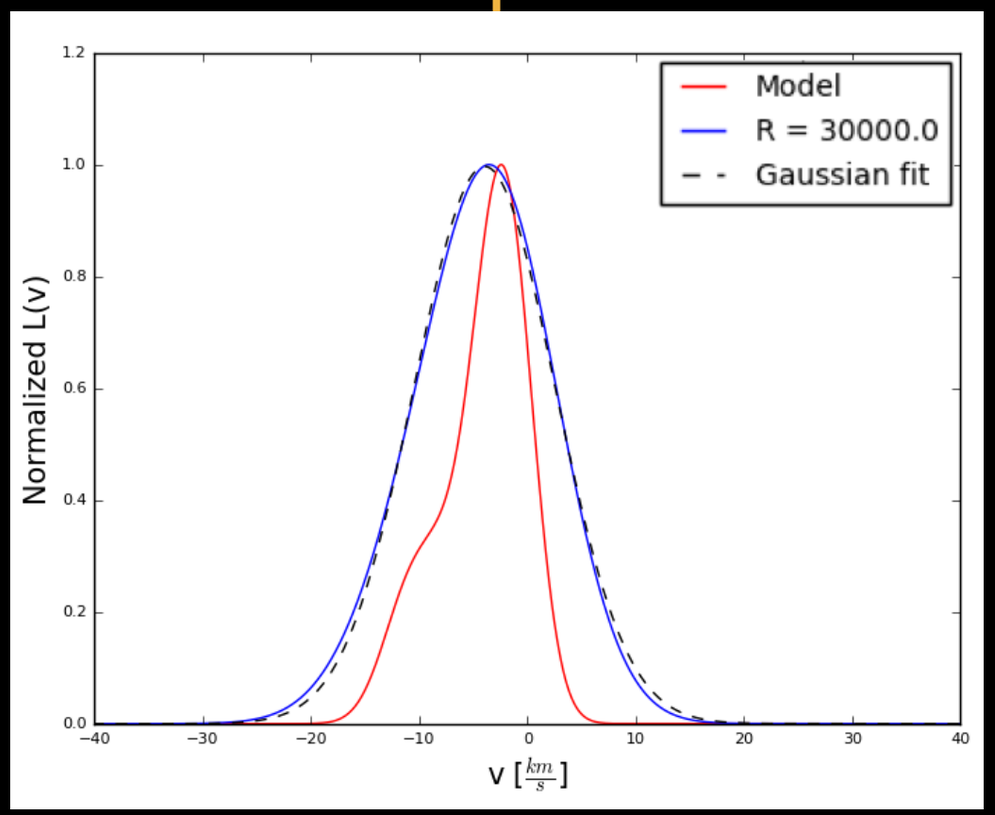
(Ballabio & Alexander in prep.)

WHAT DO WE SEE?

i=0 deg

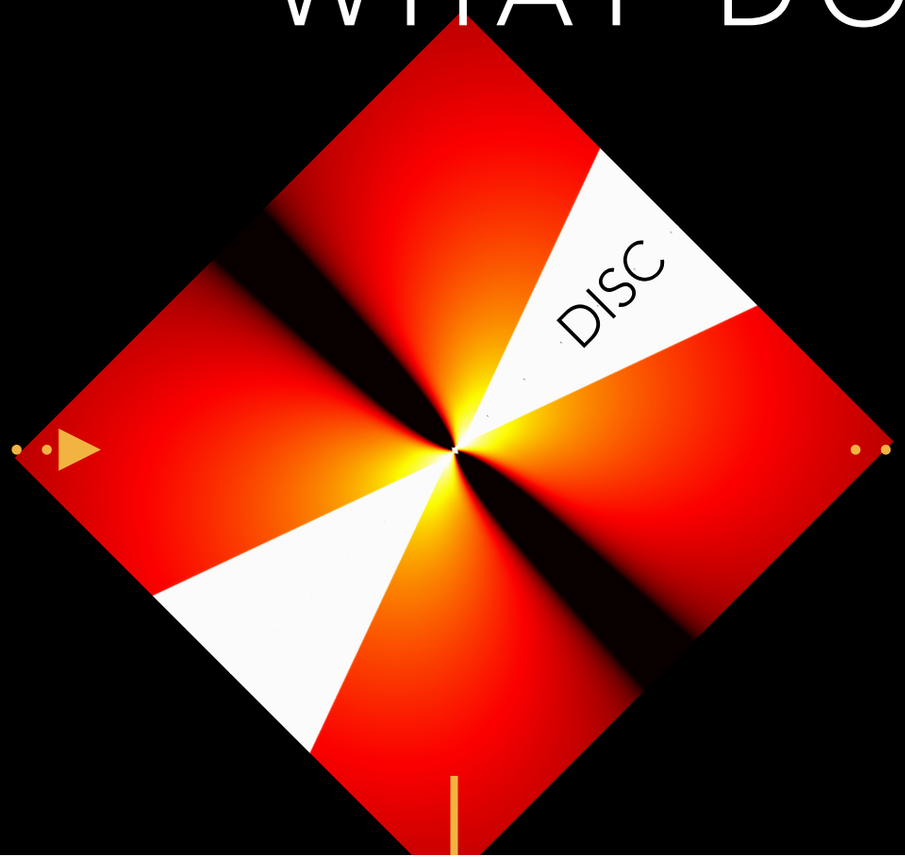


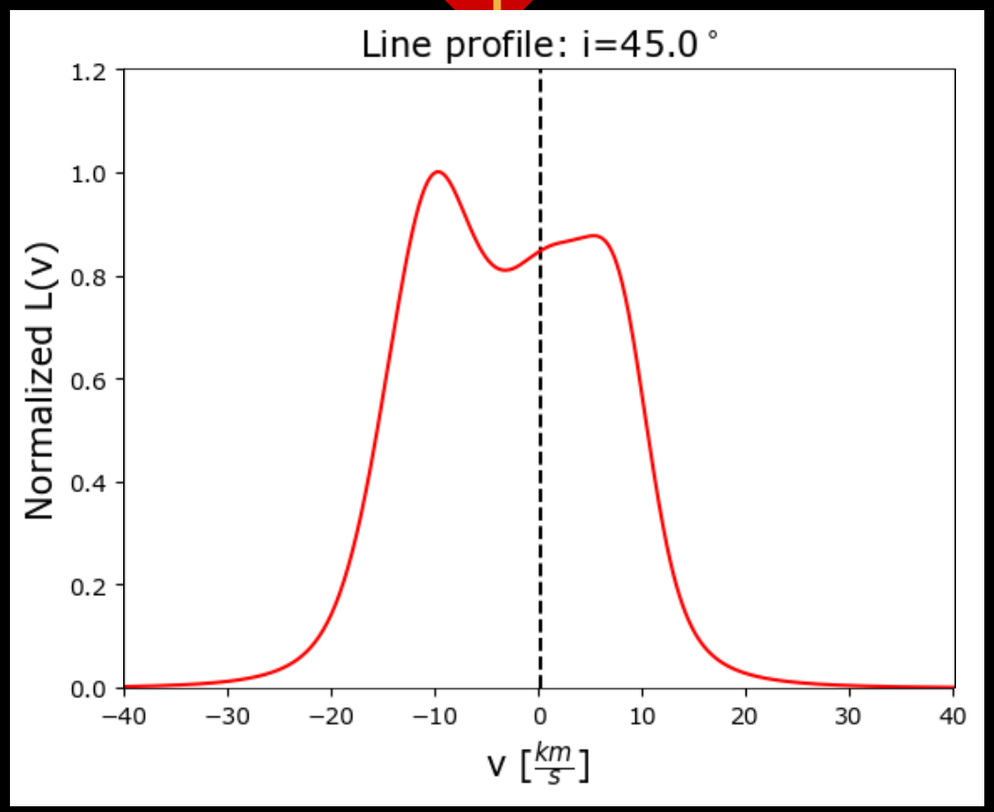


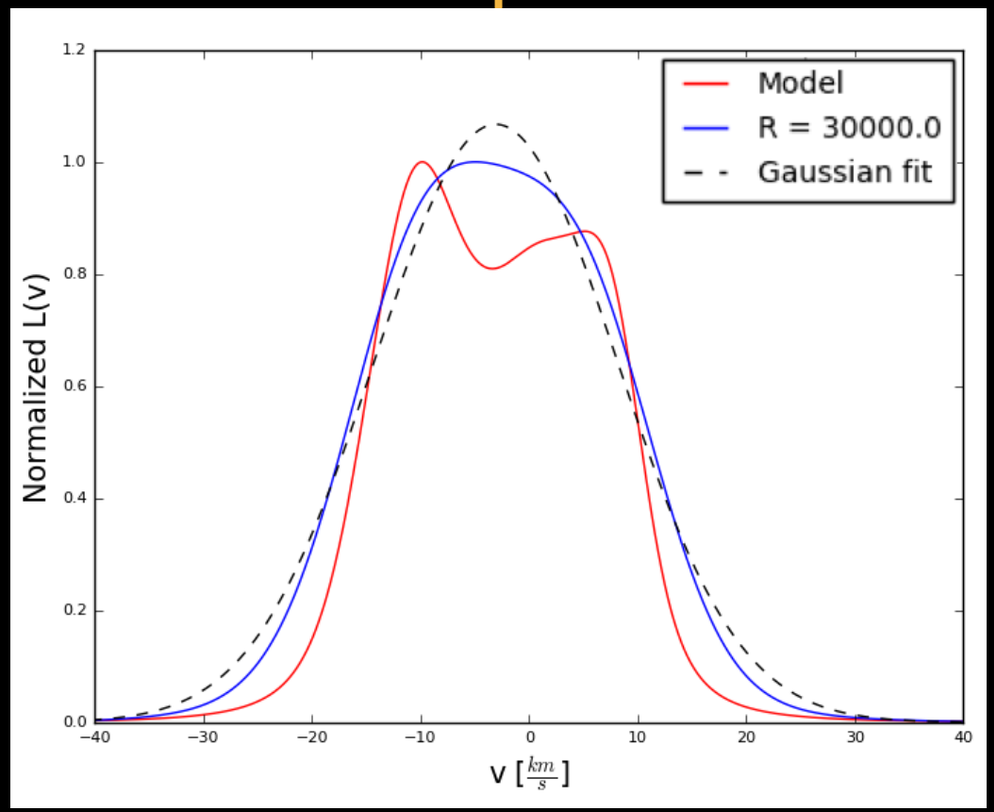


WHAT DO WE SEE?

i=45 deg

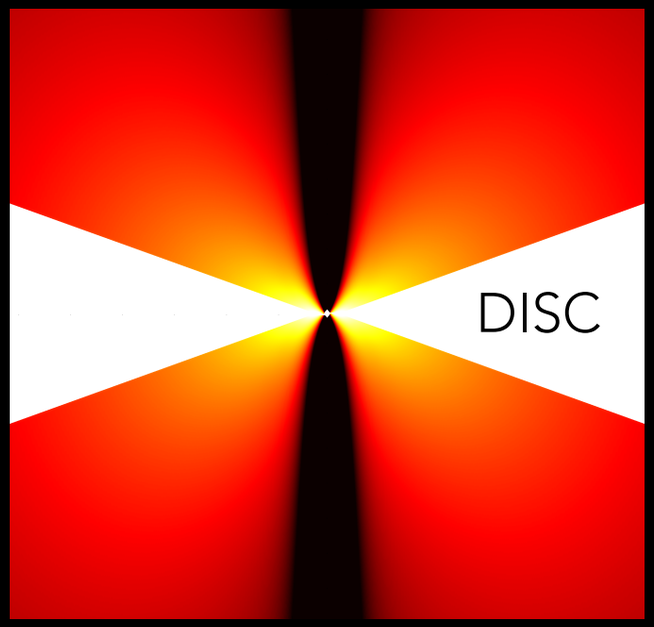


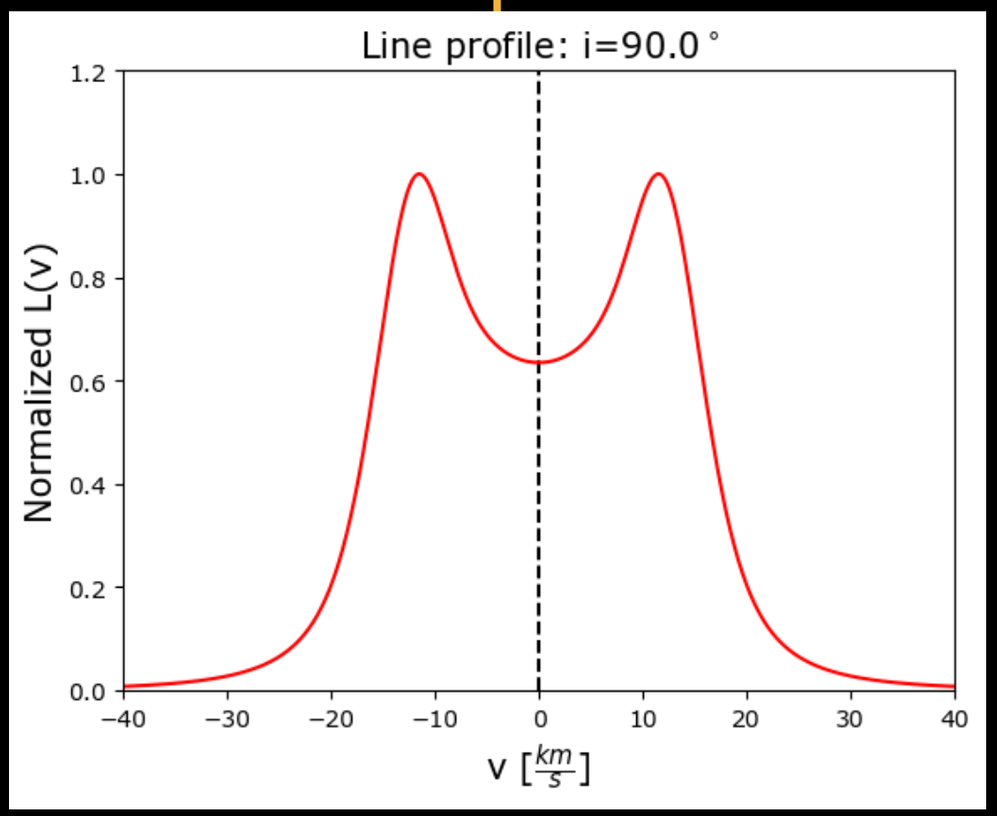


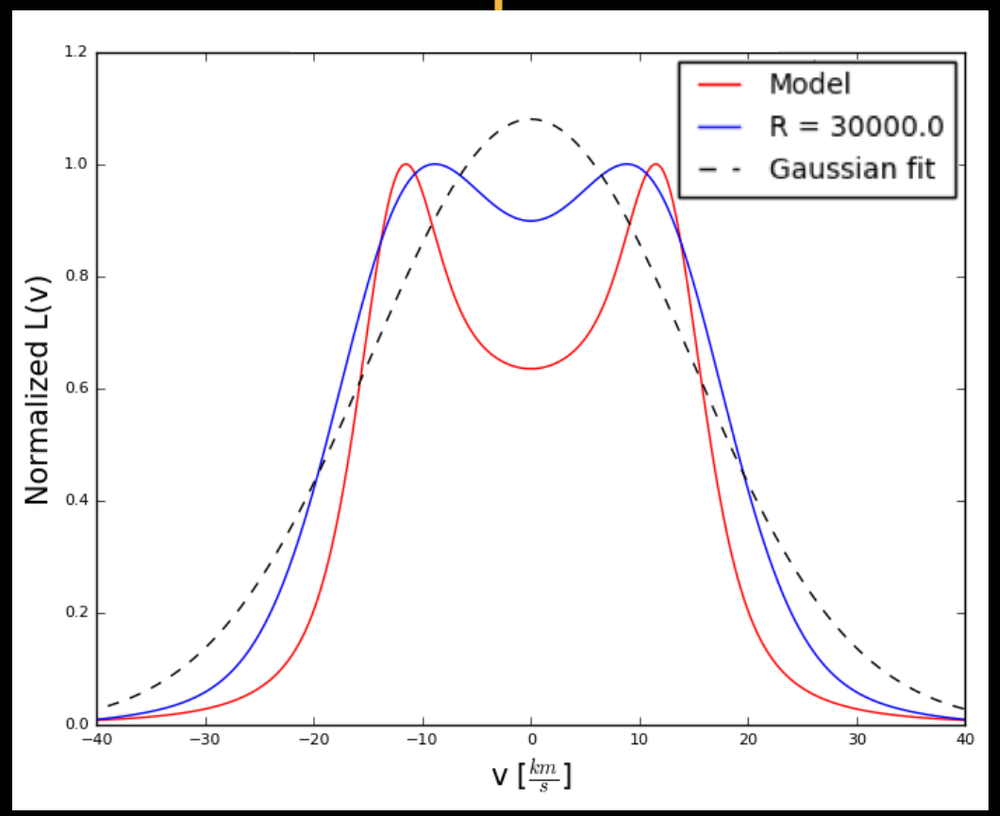


WHAT DO WE SEE?

i=90 deg

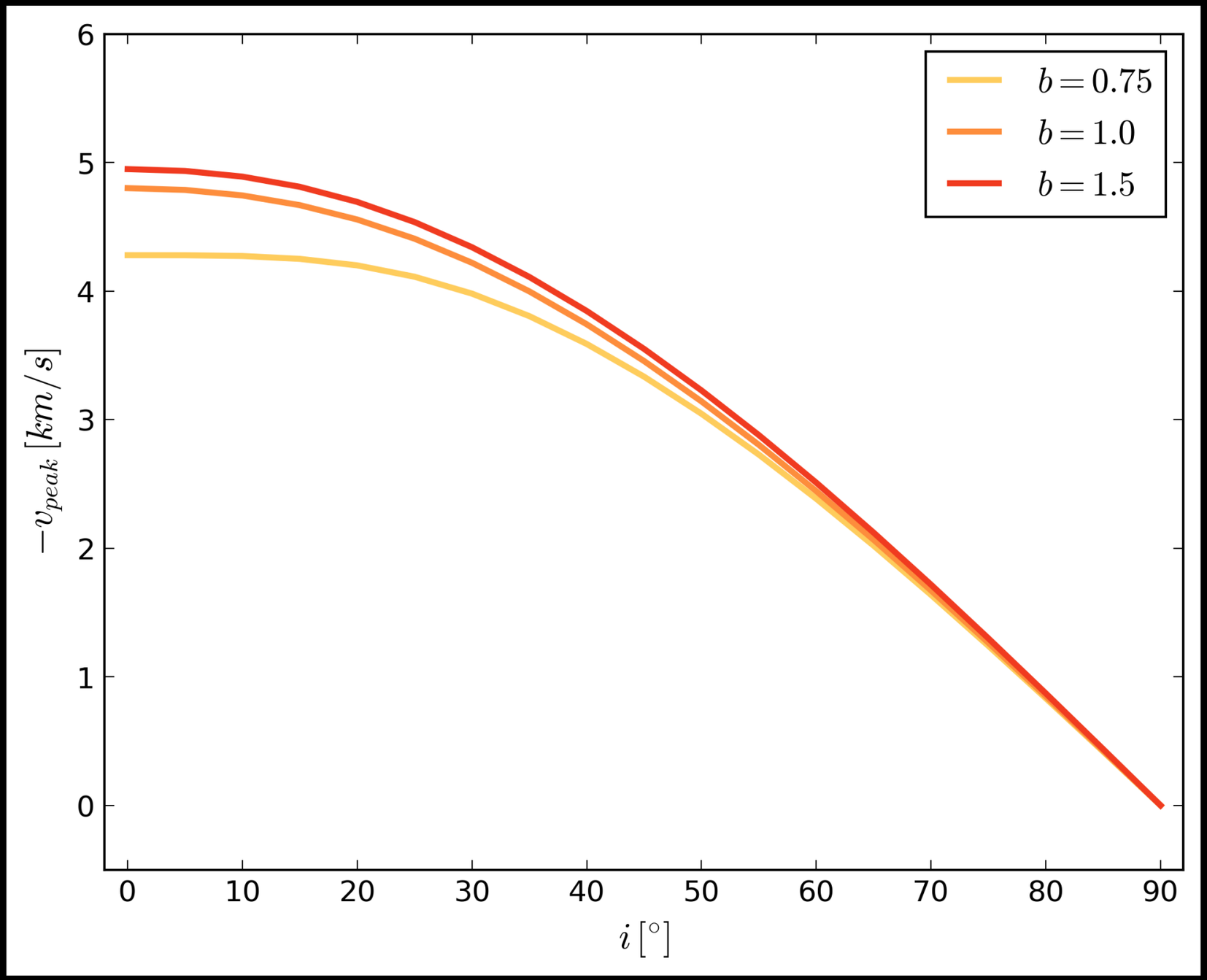






OBSERVABLES

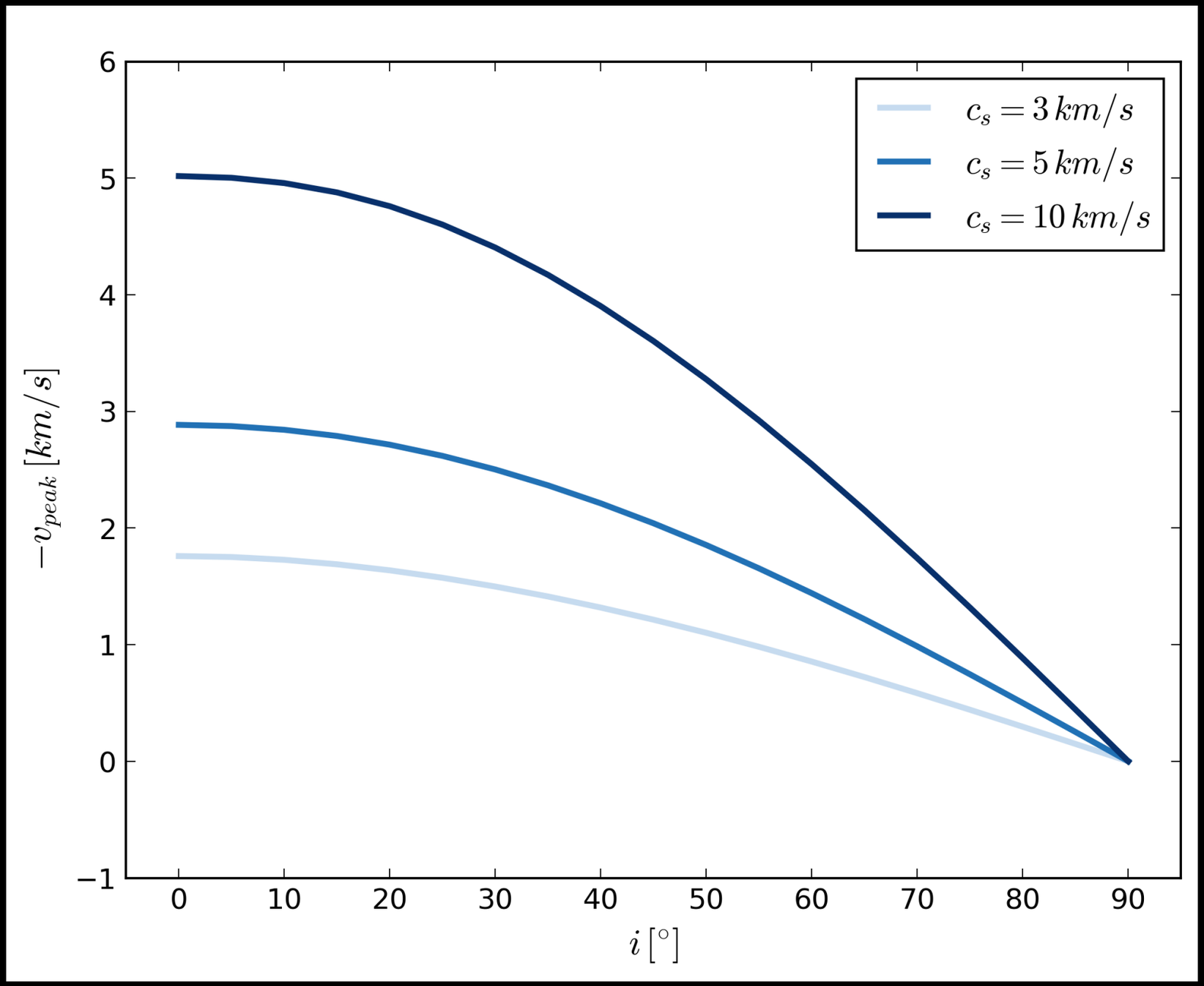
We calculate the velocity at the peak and the FWHM of each line.



(Ballabio & Alexander in prep.)

RESULTS: LINES

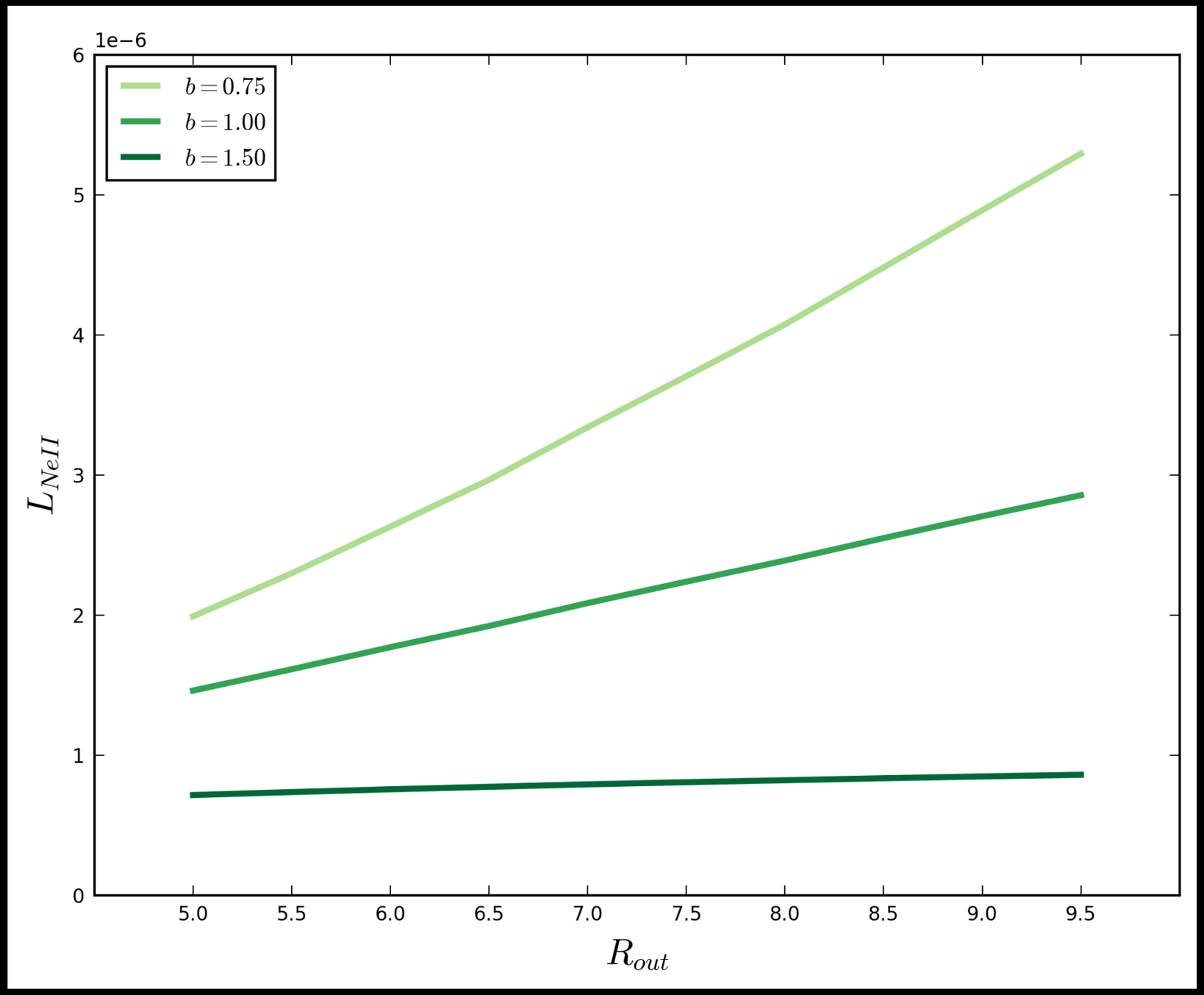
The blue-shifts are quite sensitive to the wind temperature.



(Ballabio & Alexander in prep.)

RESULTS: LINE LUMINOSITY

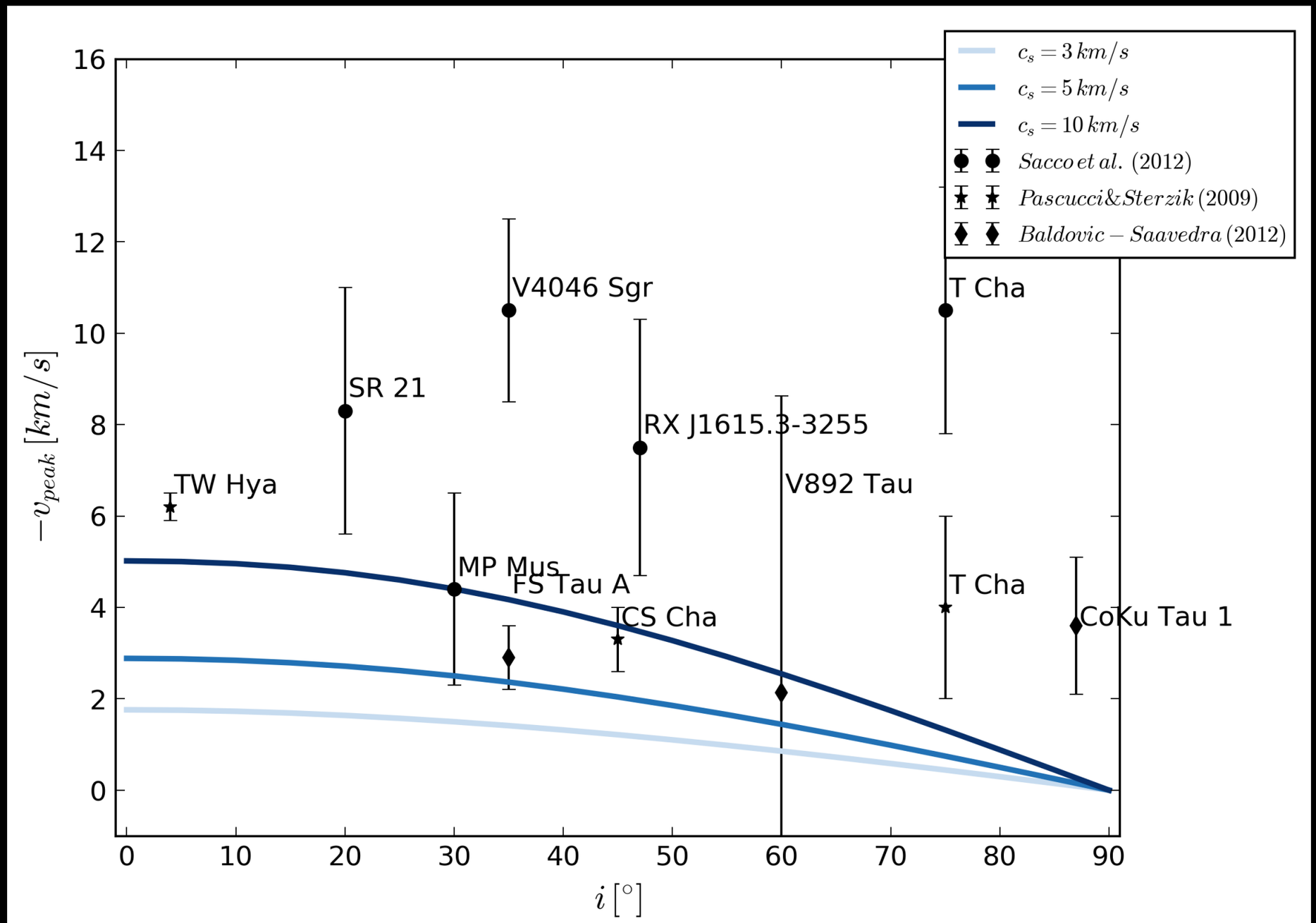
Consistent with previous work by Hollenbach & Gorti 2009.



(Ballabio & Alexander in prep.)

COMPARISONS WITH DATA

We favour slightly higher wind velocities.



(Ballabio & Alexander in prep.)

TAKE HOME MESSAGE

- We can model the **blue-shifts and width** of the lines. Our results are **consistent with previous works (**Alexander 2008, Pascucci et al. 2009, Sacco et al. 2012).

… but **limited by the resolution** of the current telescopes. We need higher resolution along with spatial information.

Line profiles -> global quantities (sound speed)
Flux -> launching region boundaries, density profile

- Talk to observers about the [OI]. The **[OI] line is puzzling**.

NEXT STEP: **Binary systems!**