XKCD: Time (frame 2395)
http://xkcd.com/1190/

Water Fountains and the Formation of Planetary Nebulae

Presentation at the IAUS 336 maser conference in Cagliari, Italy

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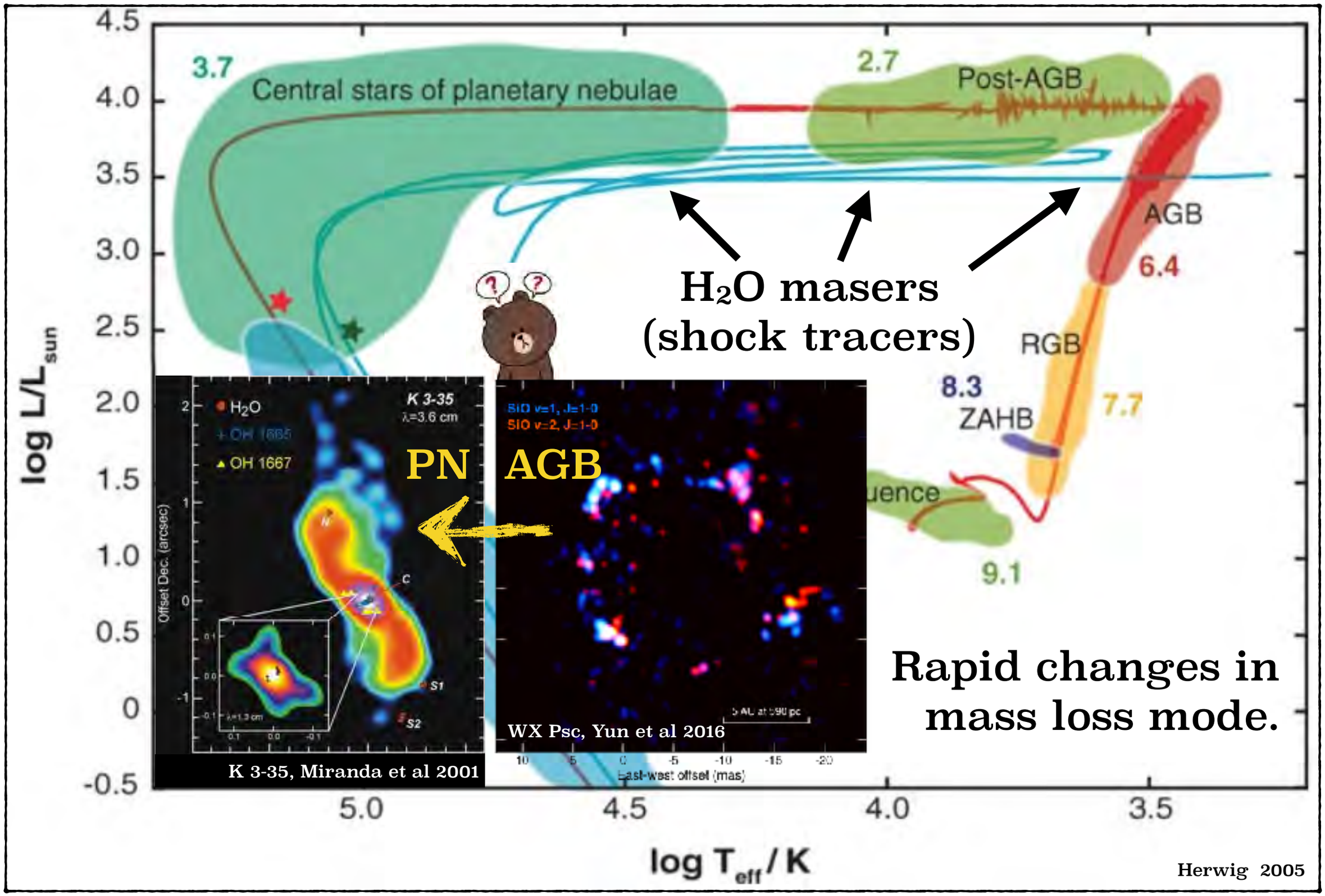
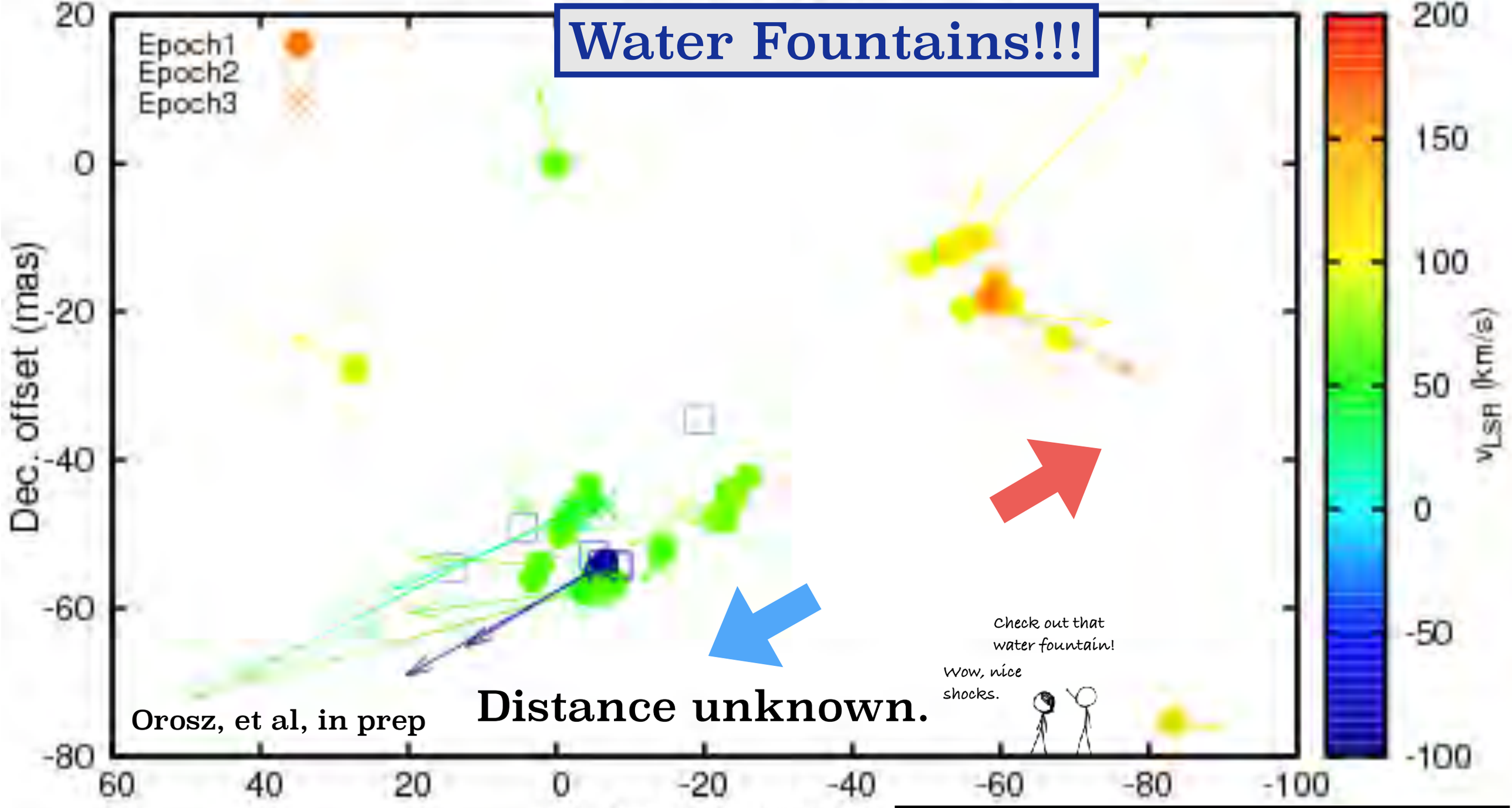
2017.09.07



Asymmetric Planetary Nebulae

Water Fountains!!!



Orosz, et al, in prep

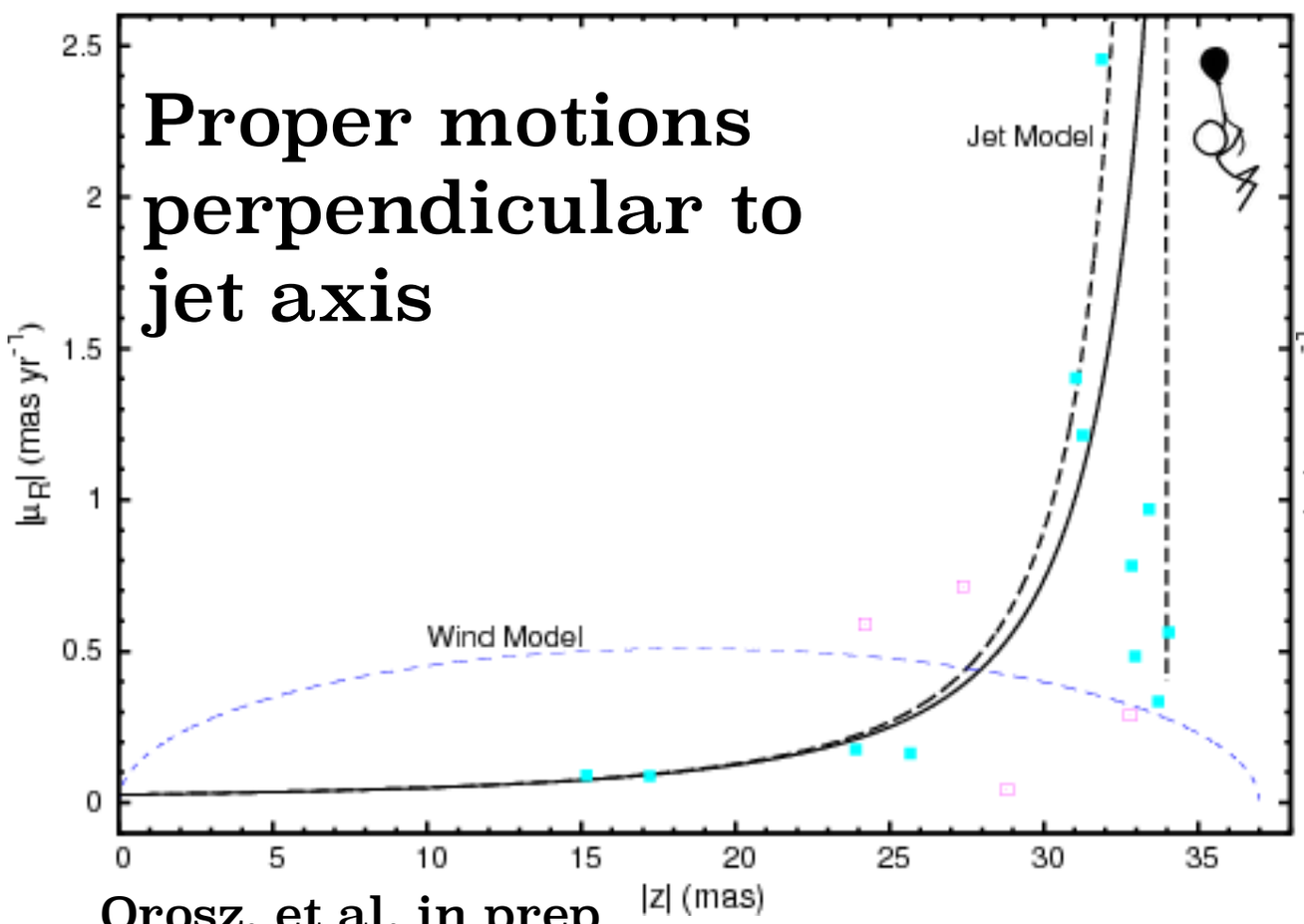
Distance unknown.

μ_{exp} ~ 1 mas/yr
T_{kin} ~ 30 years

IRAS 18043–2116
VLBA: BP150
22 GHz H_2O masers

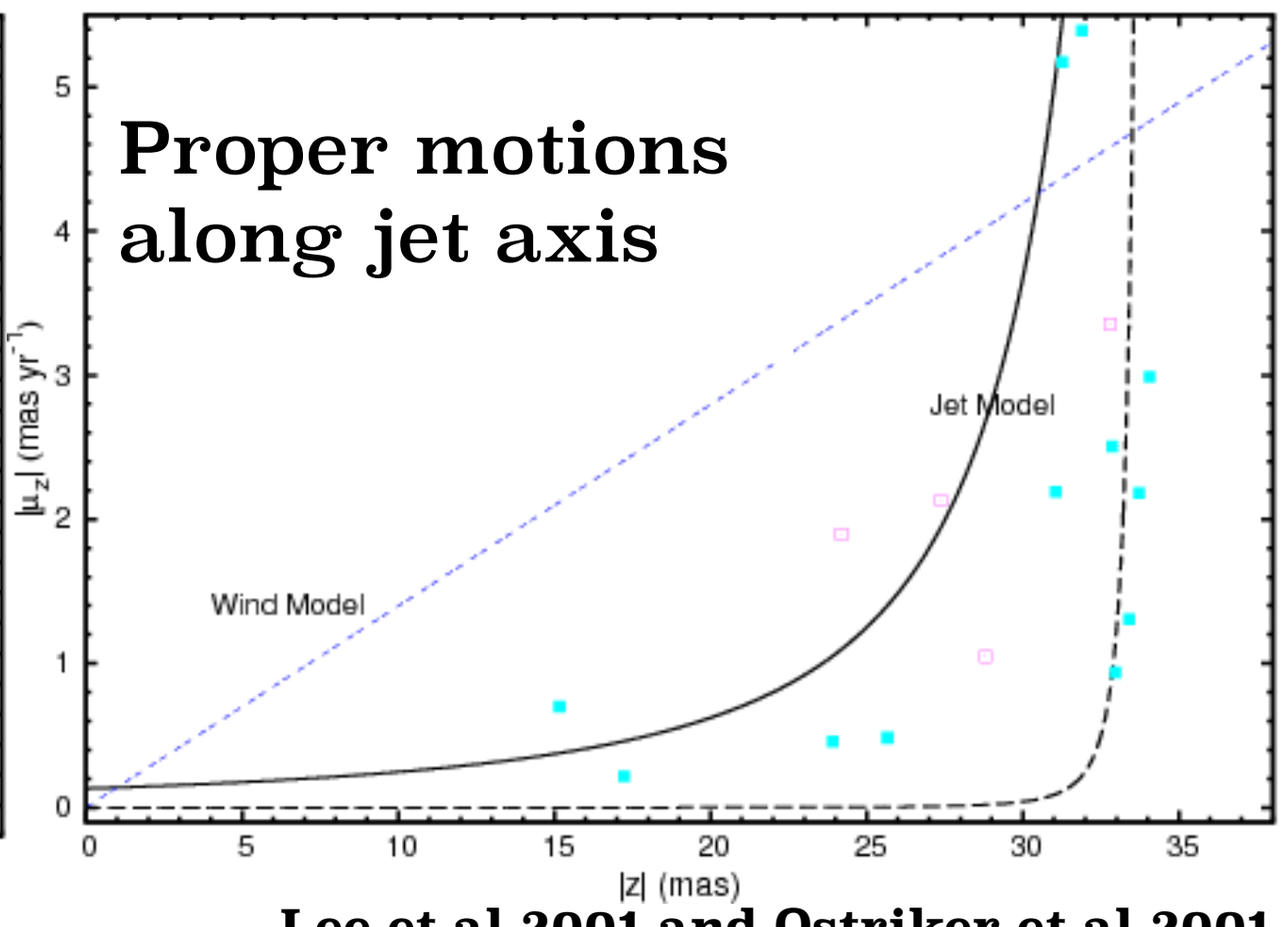
from Ann Njeri Ngendo, JIVE summer student

Proper motions perpendicular to jet axis

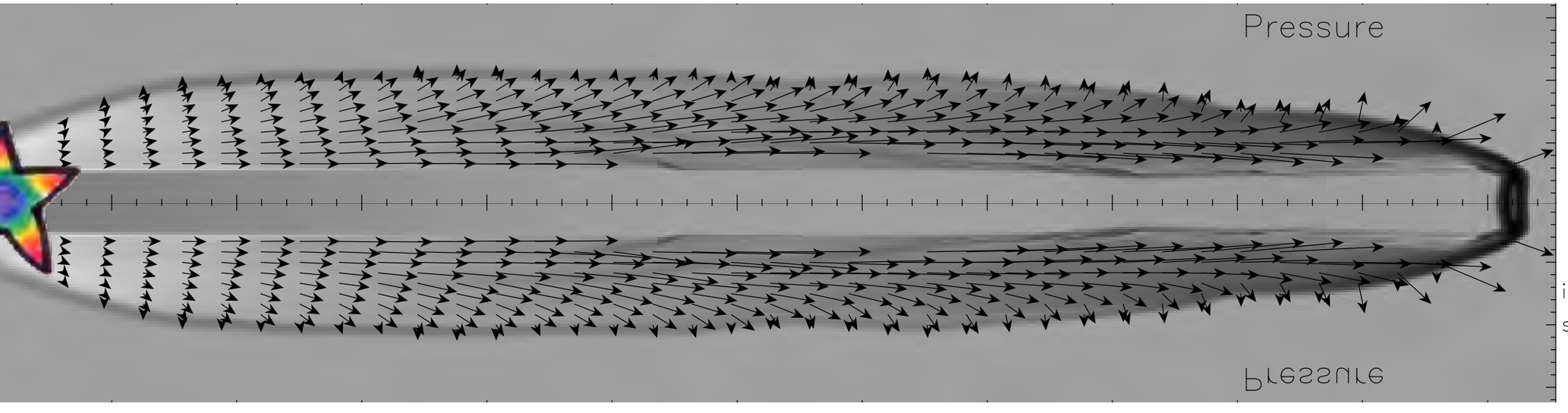


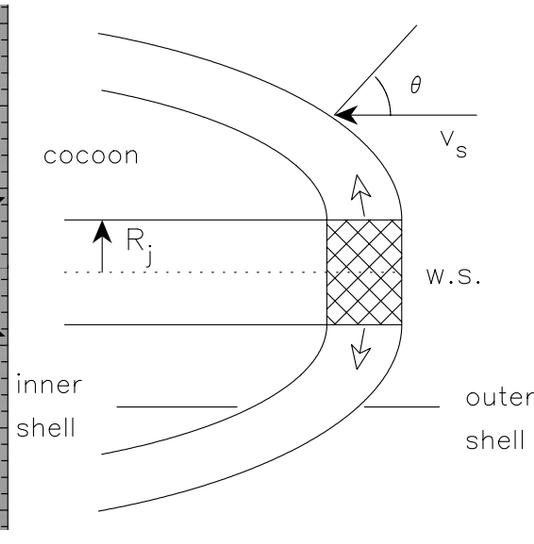
Orosz, et al, in prep

Proper motions along jet axis

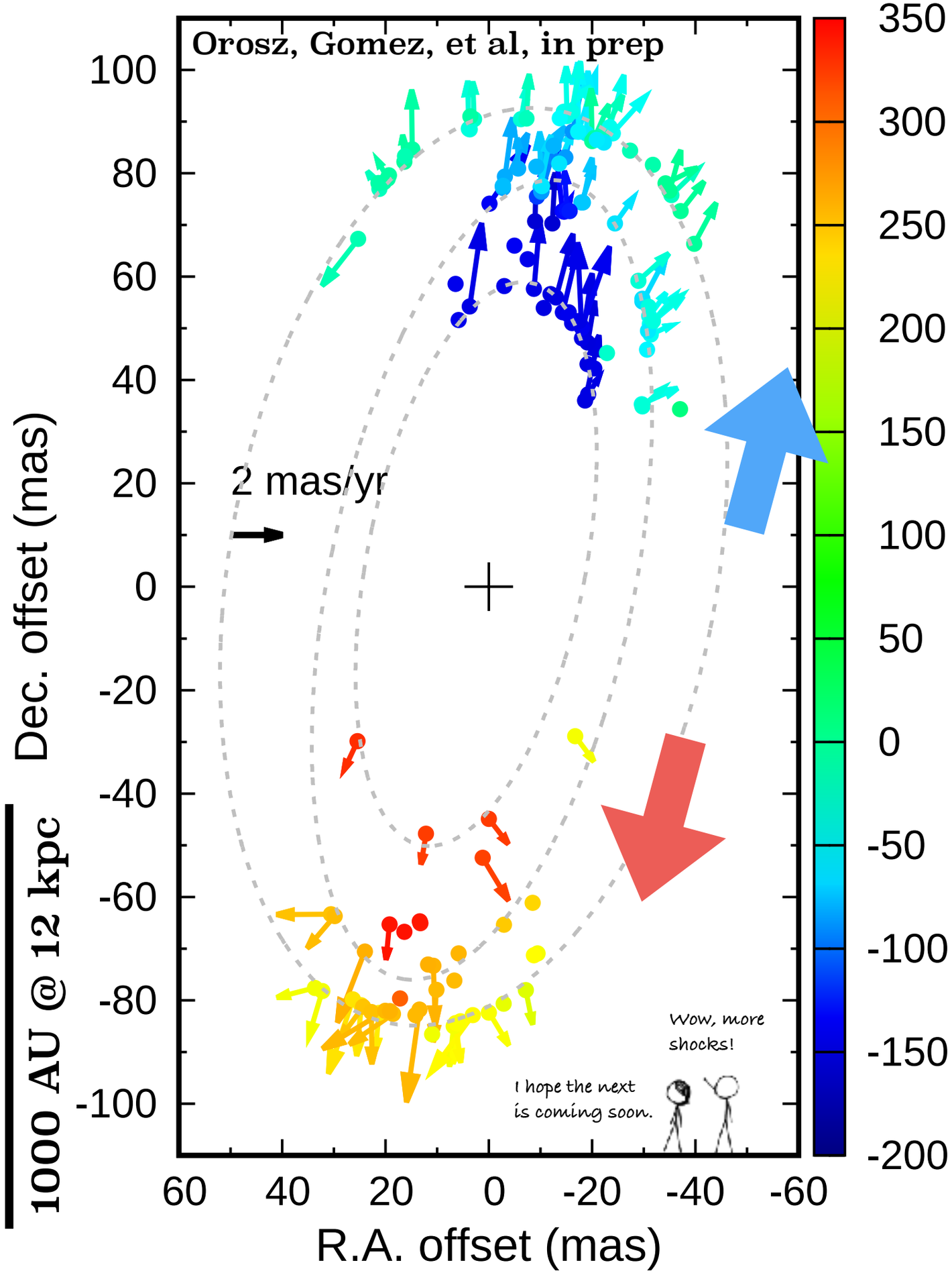


Lee et al 2001 and Ostriker et al 2001





Observations explained by the shocked shell of a collimated jet.



$$\pi = 0.082 \pm 0.016 \text{ mas}$$

$$d = 12.2^{+3.0}_{-2.0} \text{ kpc}$$

Orosz, Imai, et al, in prep

VERA 13-85: annual parallax measurement with VERA

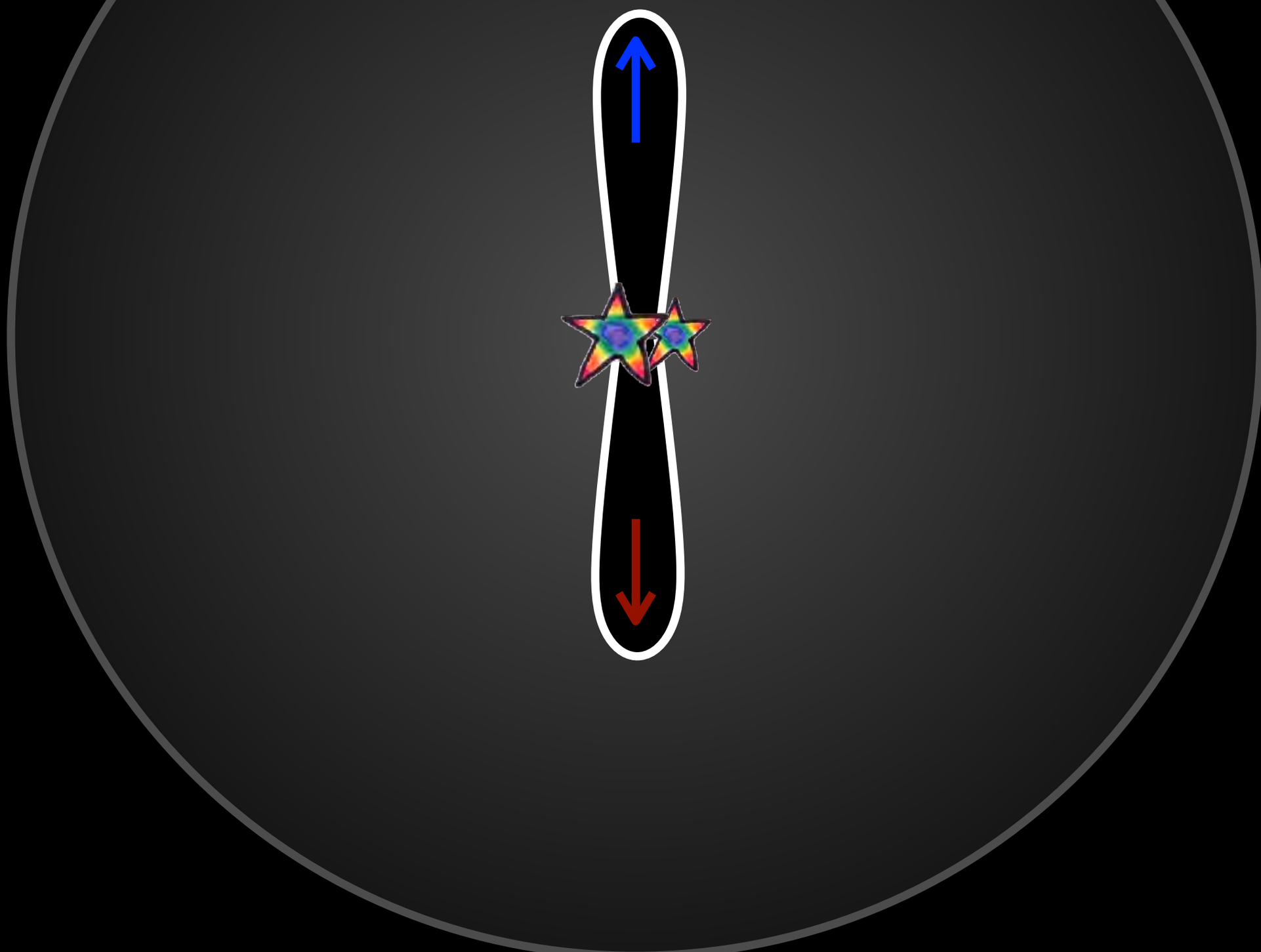
IRAS 18113–2503 H_2O masers

Masers reveal short lived episodic outbursts.

Episodes separated on a decadal timescale.

Jets are slowing down and get less collimated over time.

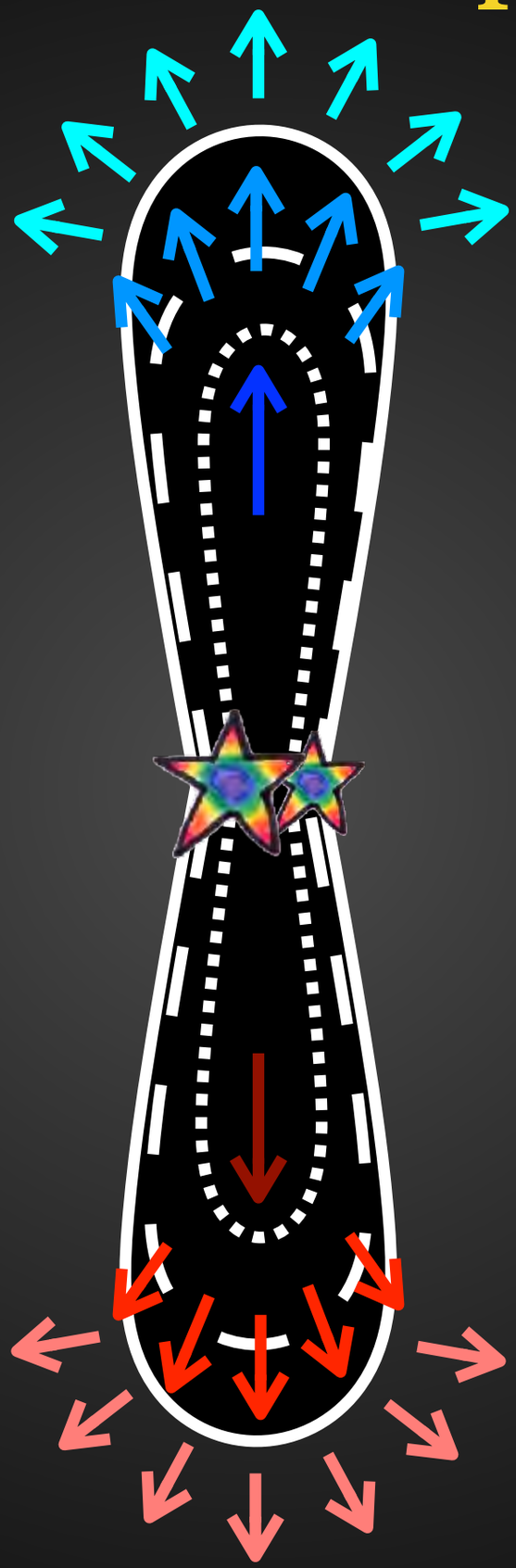
Once upon a time, there was an ejection…



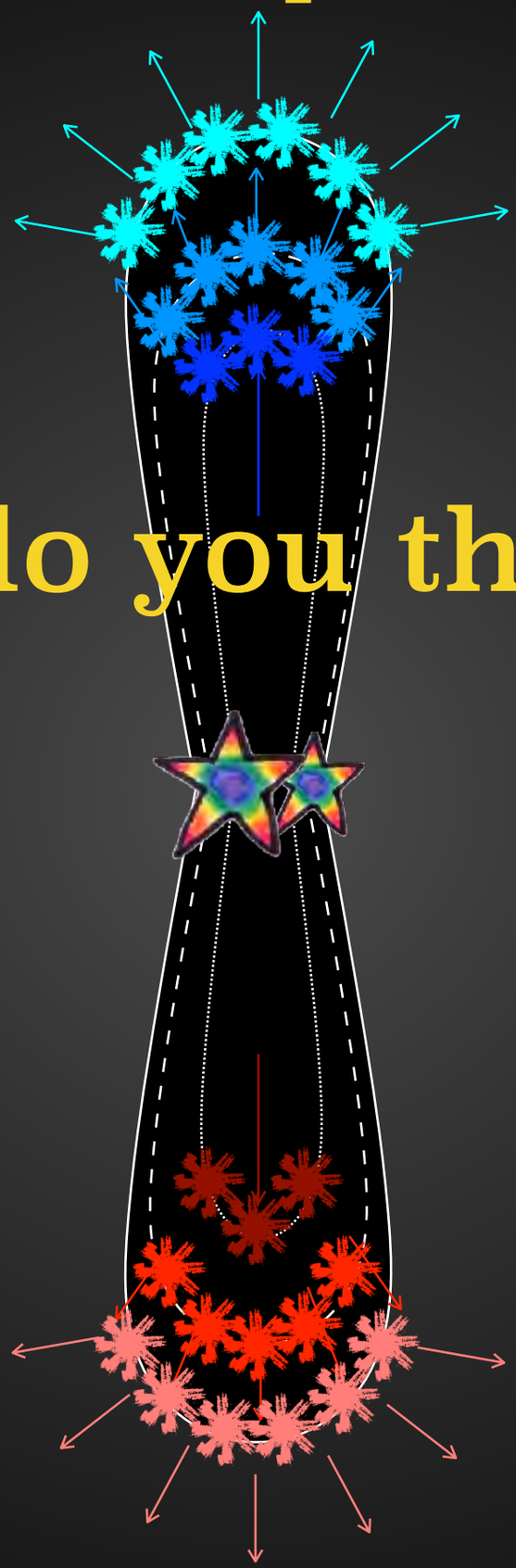
Two decades later…



Four decades later…



Perhaps observational proof of a WF binary.



What do you think???

Please tell me: gabor.orosz@gmail.com