

Circumstellar material around main-sequence stars: looking for exocomets

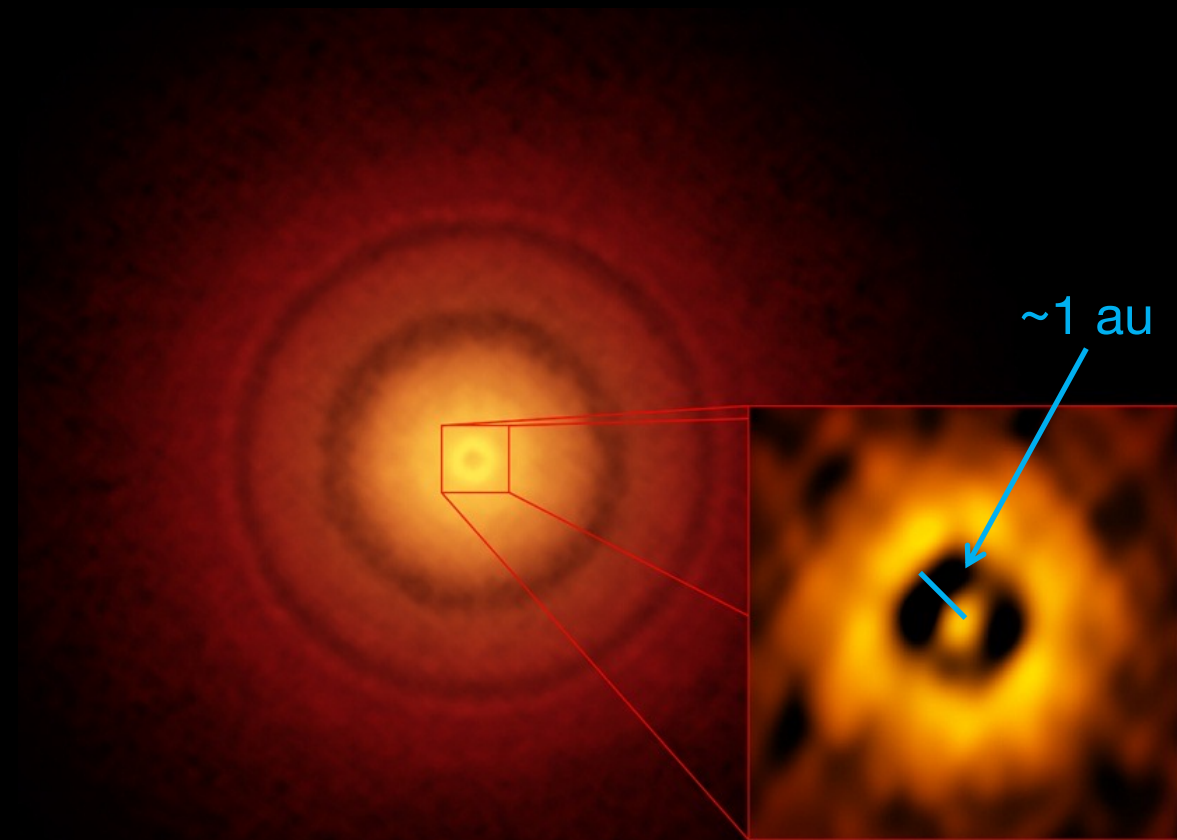
Benjamín Montesinos

Centro de Astrobiología (CAB) CSIC-INTA

Why a talk on exocomets?

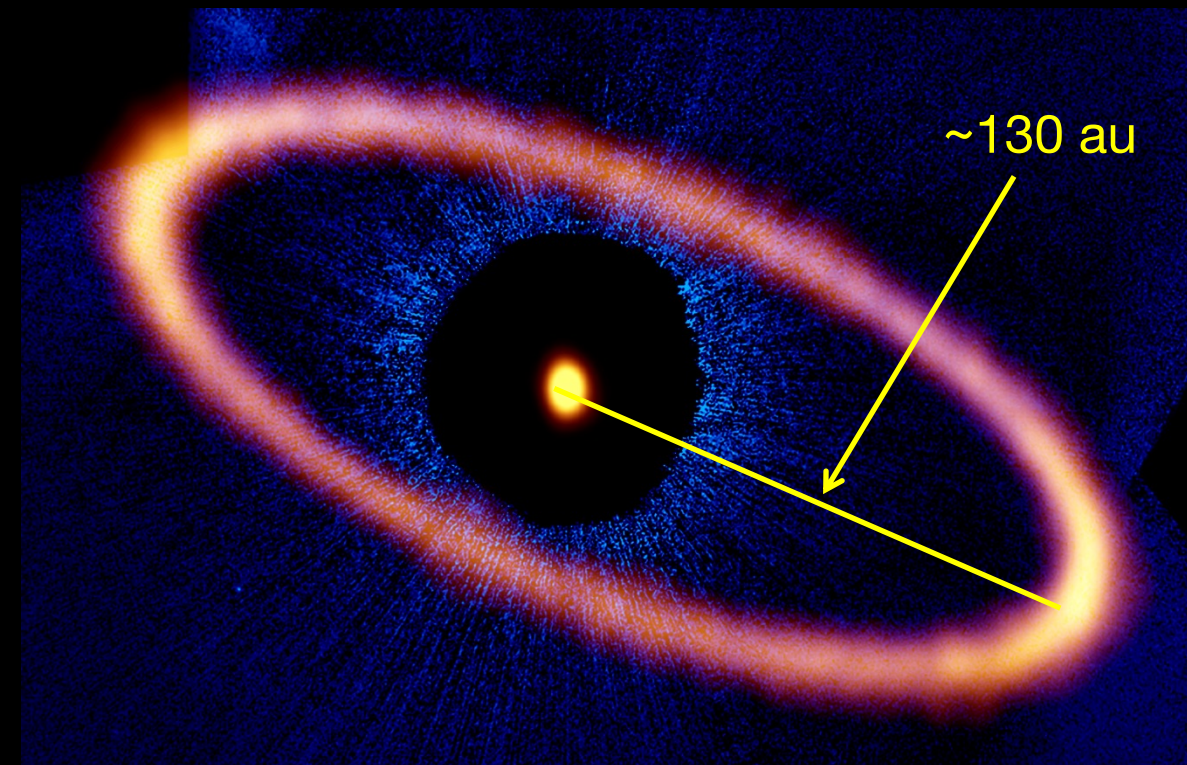
- Comets are the most abundant bodies in the Solar System and have played an important role in their architecture, hence they must also be important in the context of exoplanetary systems.
 - Exoplanets are now routinely detected **(5000+)**, but in contrast...
 - We have little information about small bodies (asteroids and comets):
 - **Only ~25 stars (A-type, two F)** detected with potential exocometary activity.
- Since 2017, about 1500 Sun-grazing comets ($d < 12 R_{\odot} = 0.055 \text{ au}$) have been detected... however **no comets around G-type stars have been found so far.**

Circumstellar (CS) environments



TW Hydrae (K6 V, 10 Myr) ALMA

PMS: Protoplanetary disk made of gas and dust (gas/dust~100). Gas depleted in a few tens of Myrs

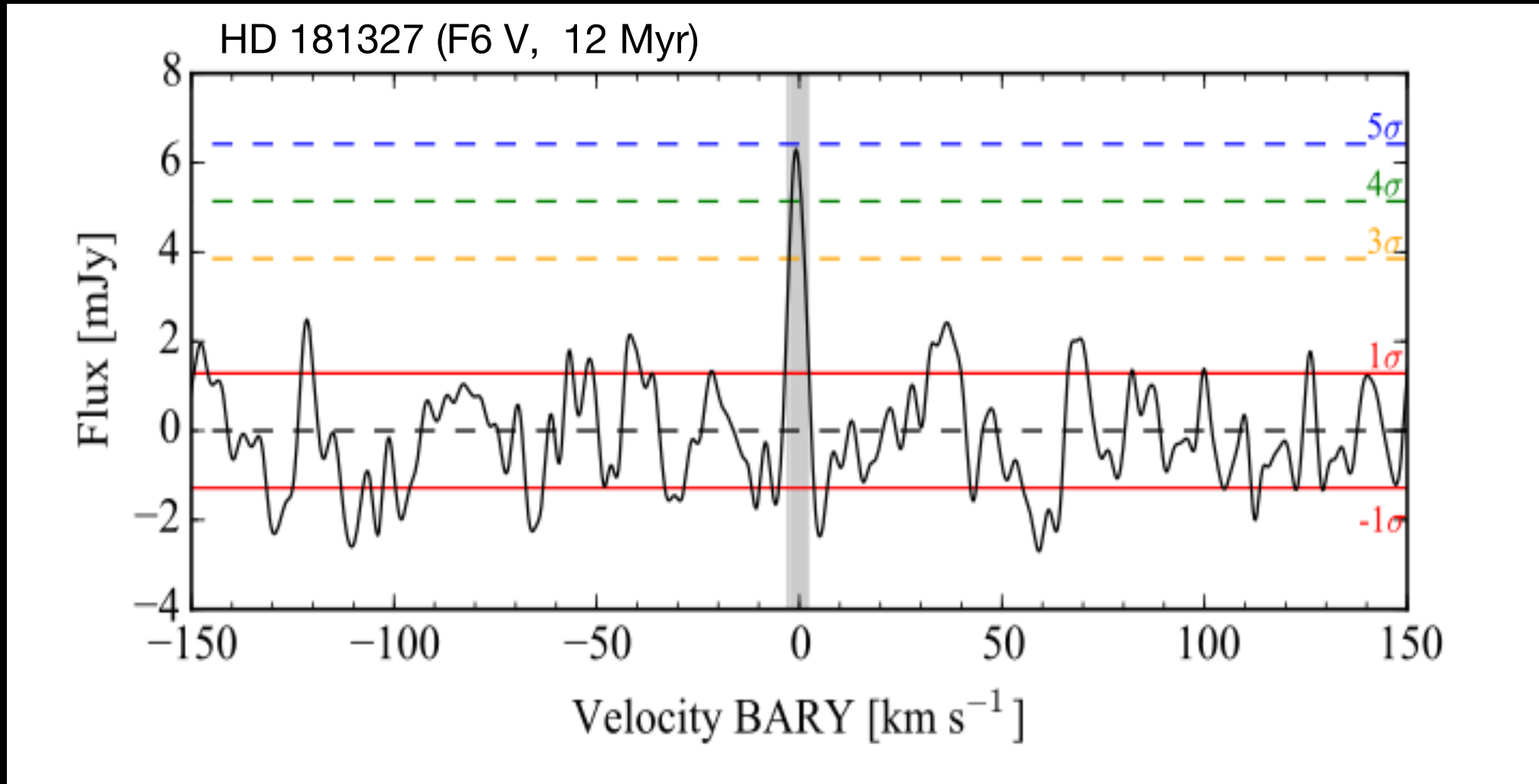


Fomalhaut (A4 V, 440 Myr) ALMA + HST

MS: Debris disks made of second generation dust, from collisions of planetesimals, but in some cases also showing traces of gas

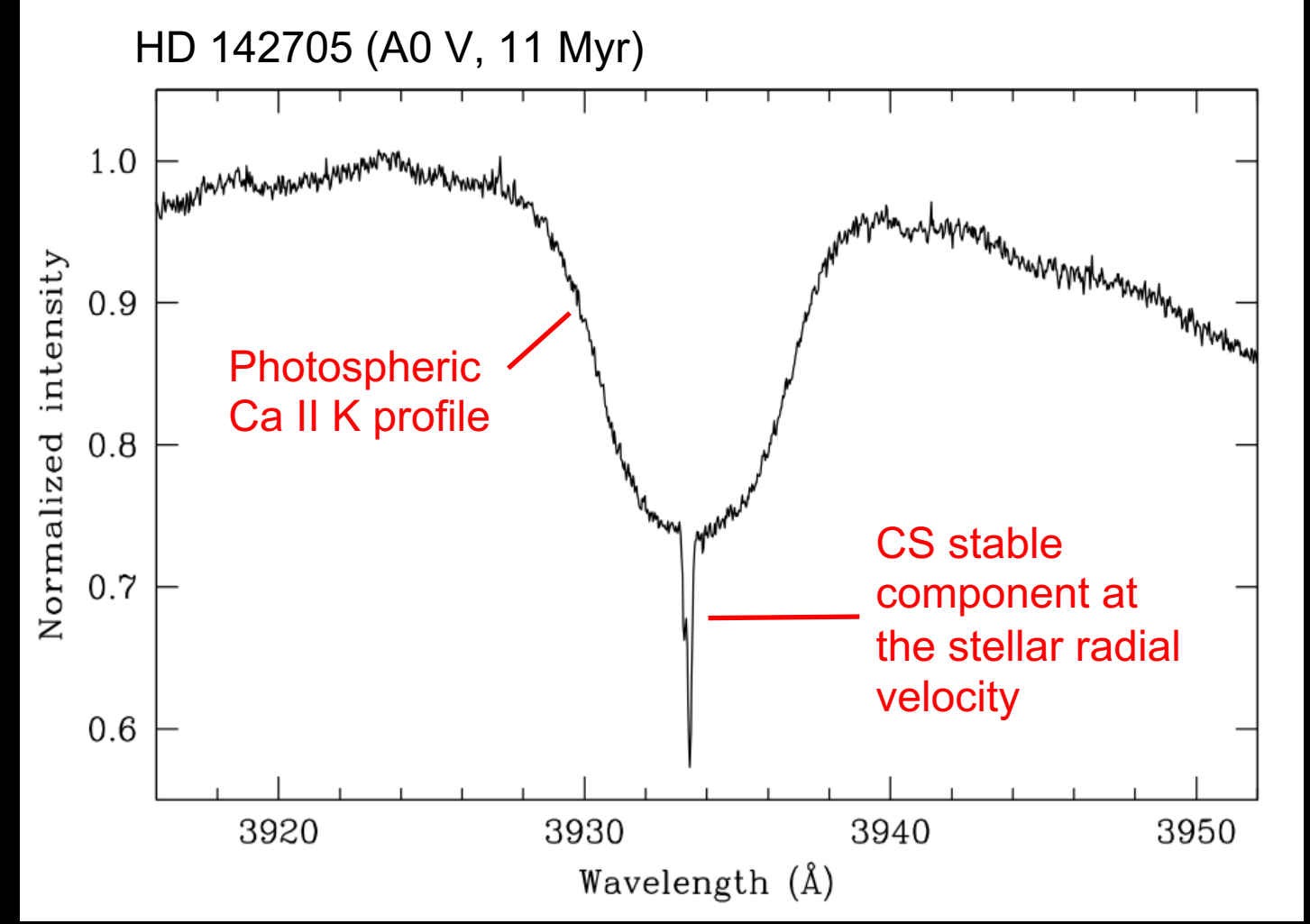
MS: "Shell stars" surrounded by an envelope of gas.

Cold CS gas (~50 K)



5σ detection of ^{12}CO (2-1) linked to a debris disk (Marino et al. 2016)

Warm CS gas (~1000 – 2000 K)



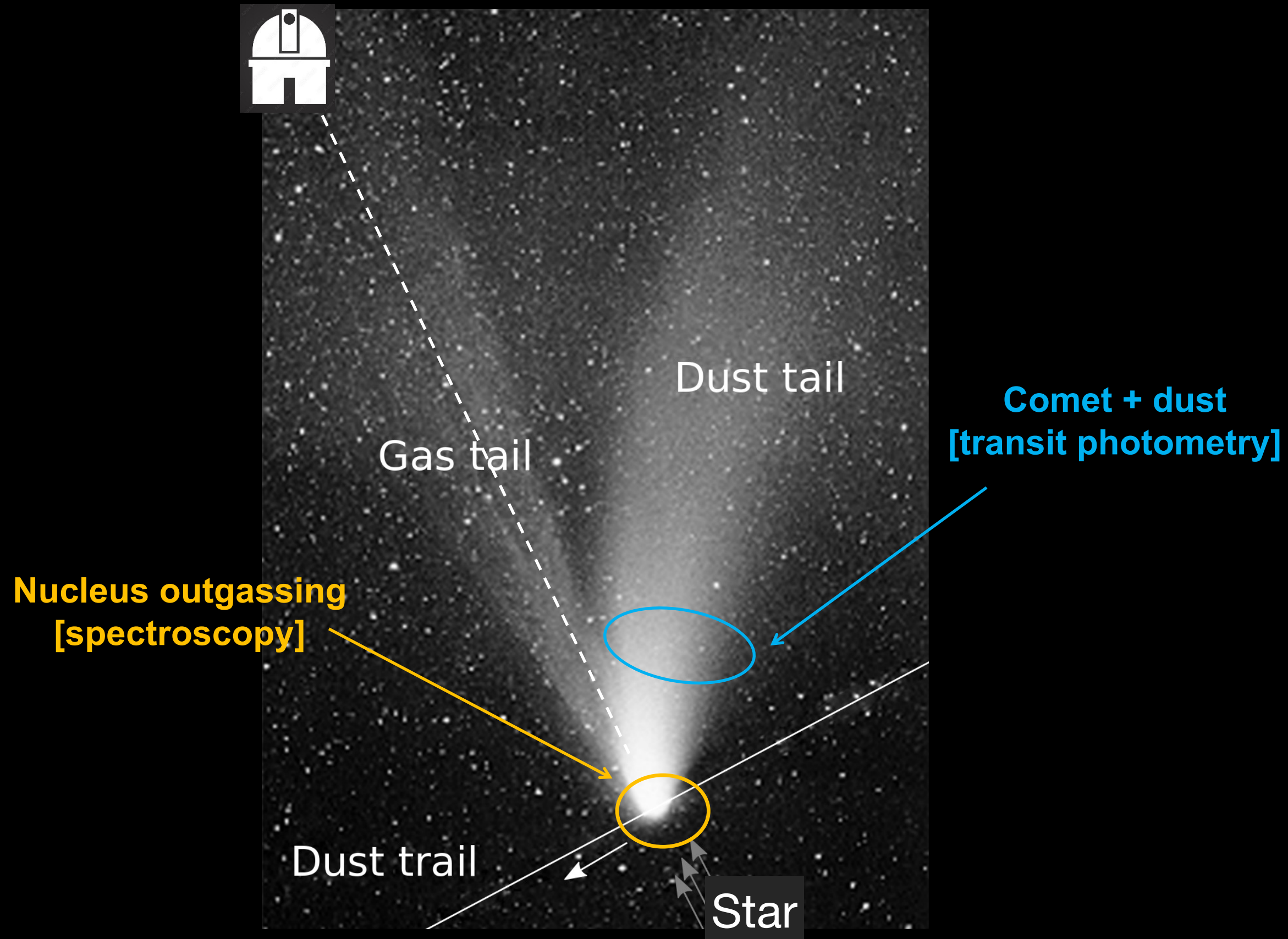
Rebollido et al. (2019)

Origin of gas?...

Primary: remnant from protoplanetary disc (e.g. Kóspál et al. 2013), or

Secondary: evaporation of icy bodies, colliding comets or planetesimals, grain-grain collisions (e.g. Matthews et al. 2014).

What about exocomets?: How to detect them



β Pic

Spectral type A6 V

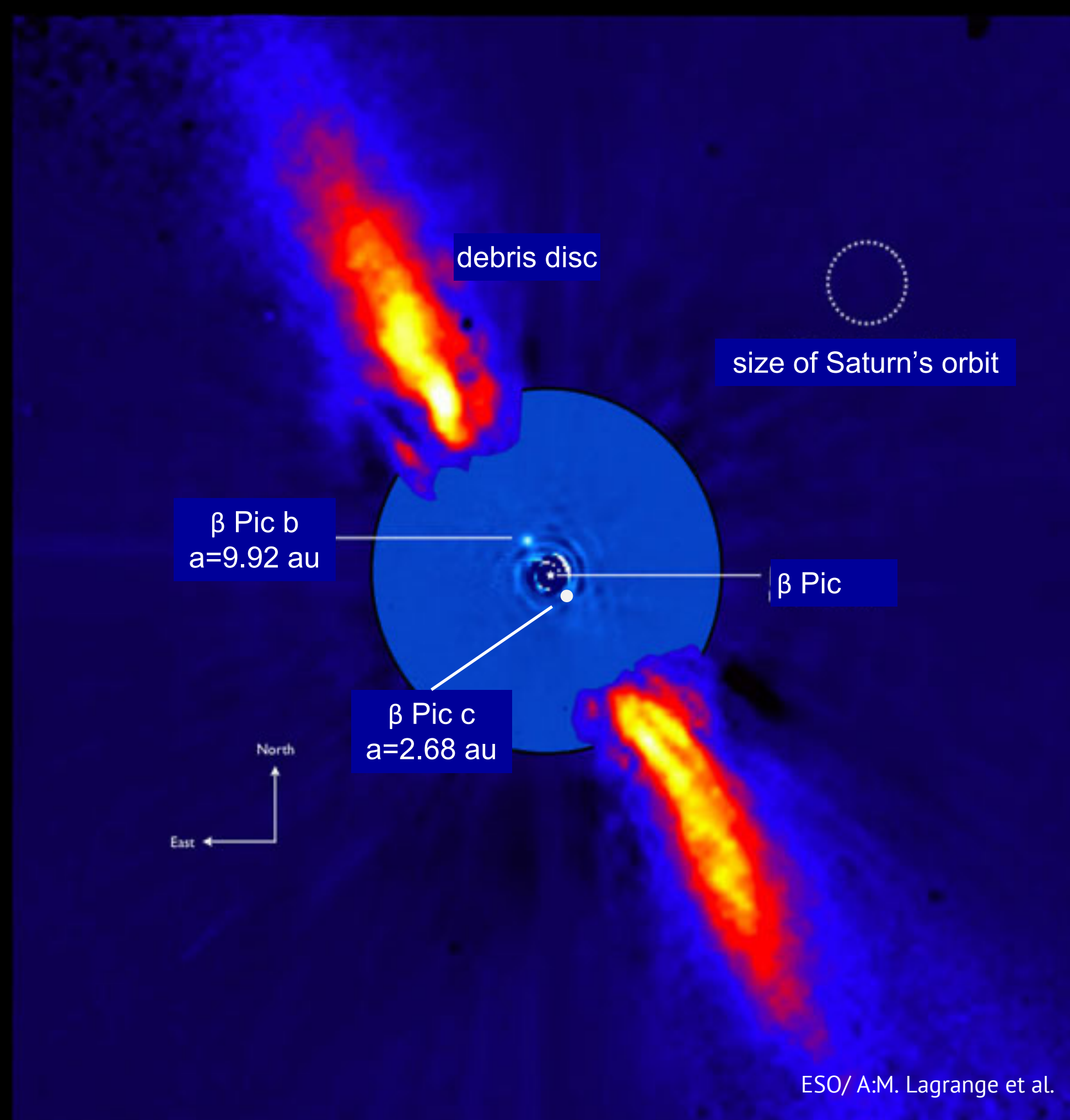
$d = 19.4$ pc

$T_{\text{eff}} = 8050$ K

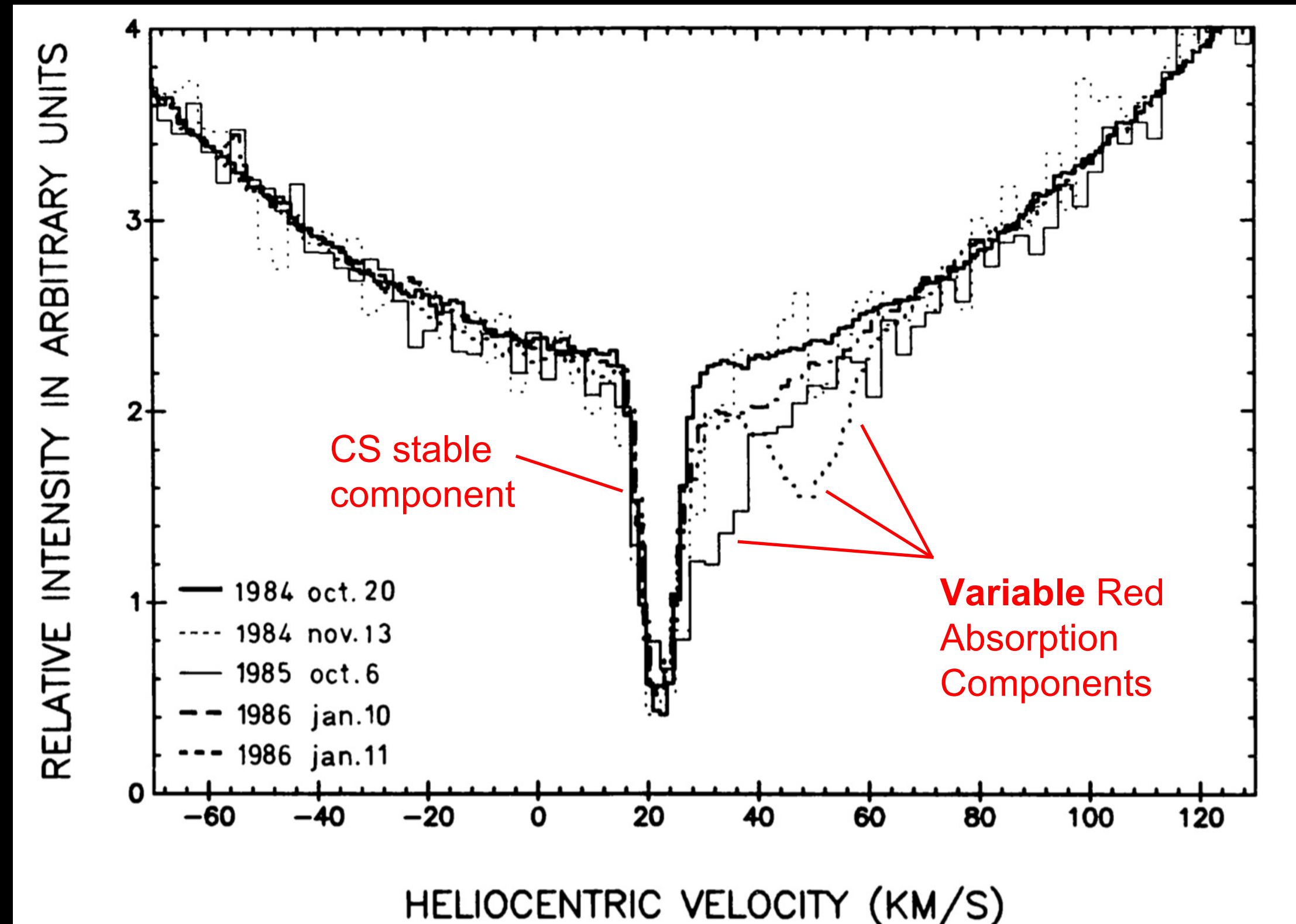
$\log g = 4.15$

$L = 8.7 L_{\odot}$

Age ~ 23 Myr

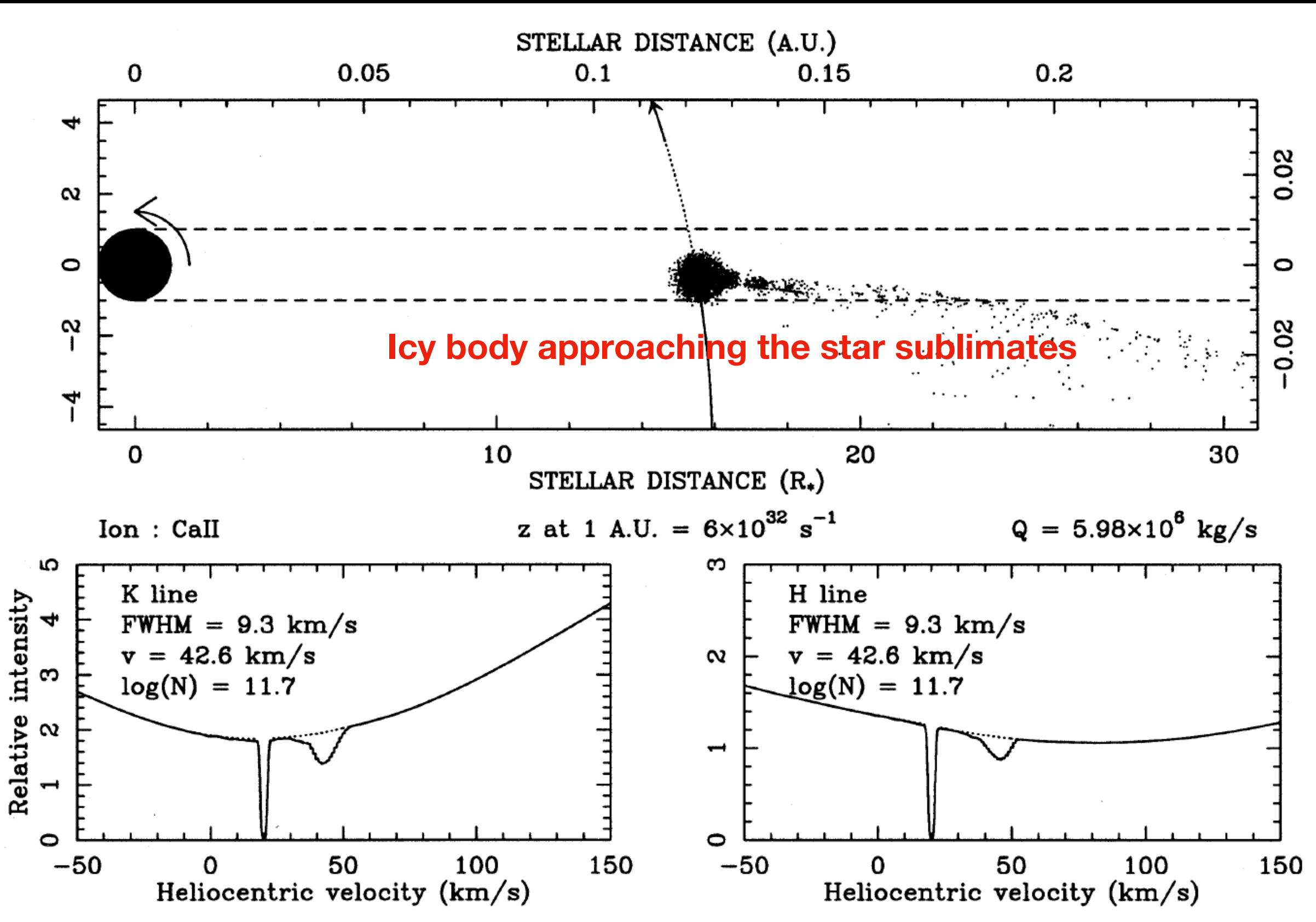


How to detect exocomets: spectroscopy



First report of exocomets: Ca II K profile in β Pic (Ferlet et al., 1987)

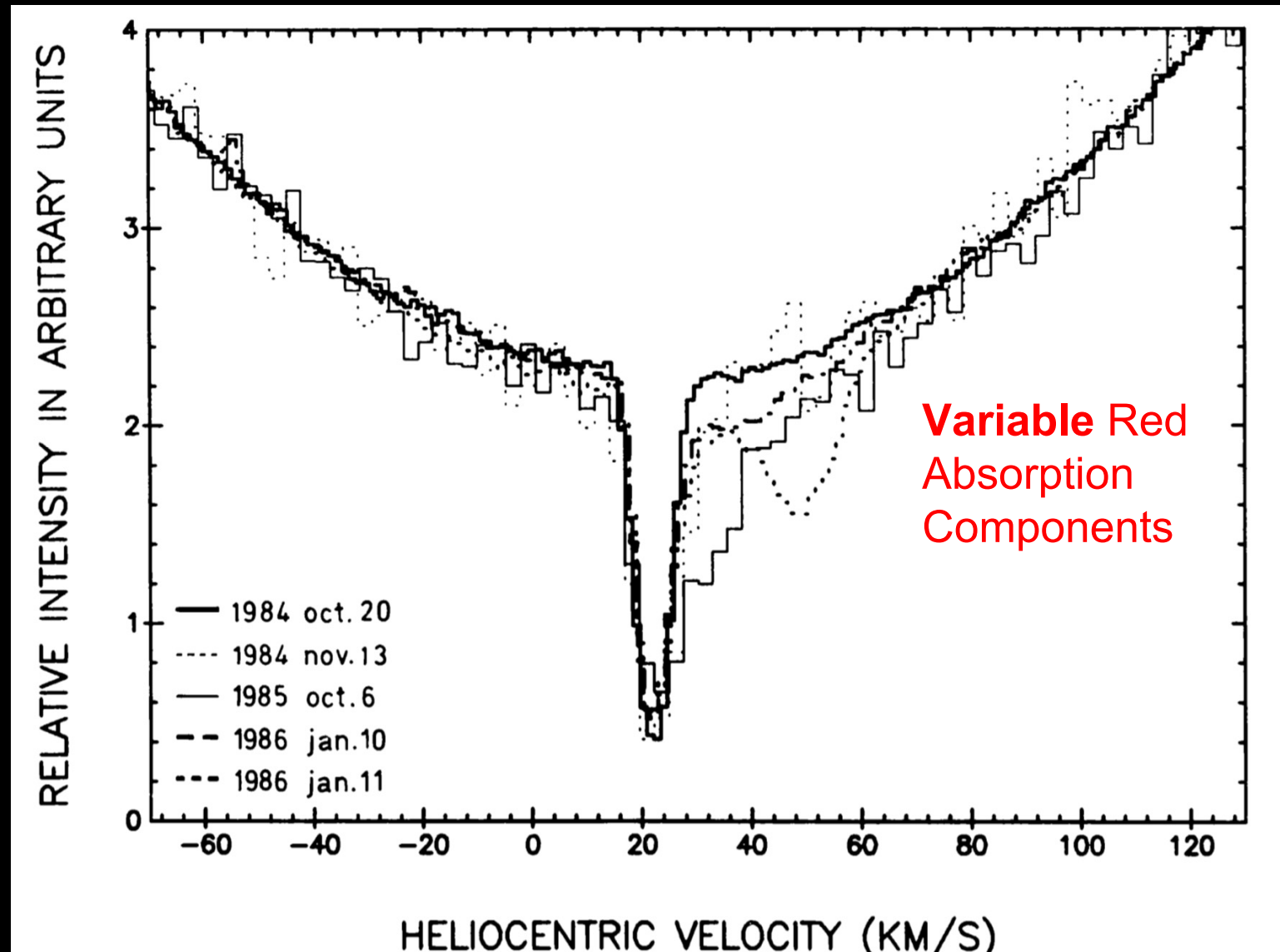
The Falling Evaporating Body (FEB) scenario



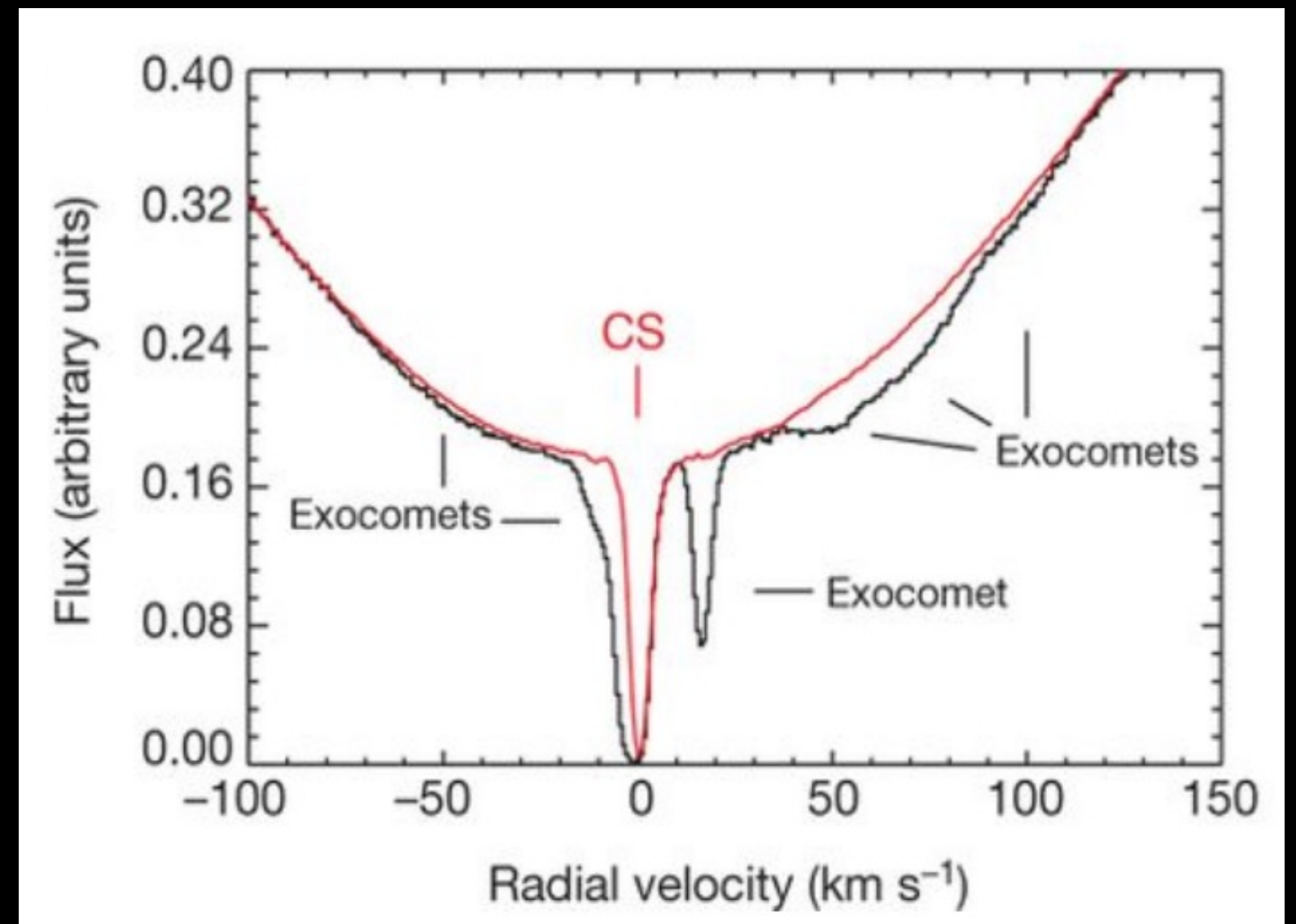
The Falling Evaporating Body (FEB) scenario

Red Absorption Components \equiv **Falling Evaporating Bodies (FEBs)**
 \equiv **Exocomets**

β Pic Ca II K profile

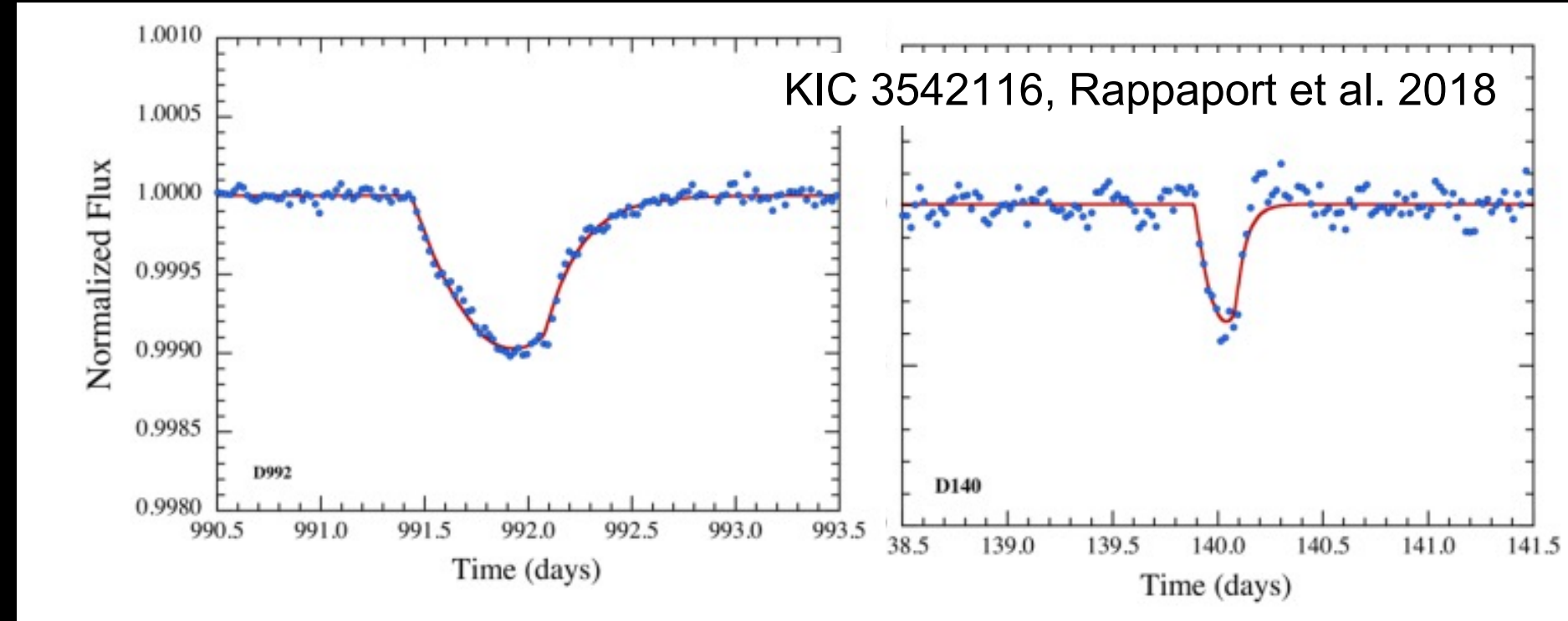
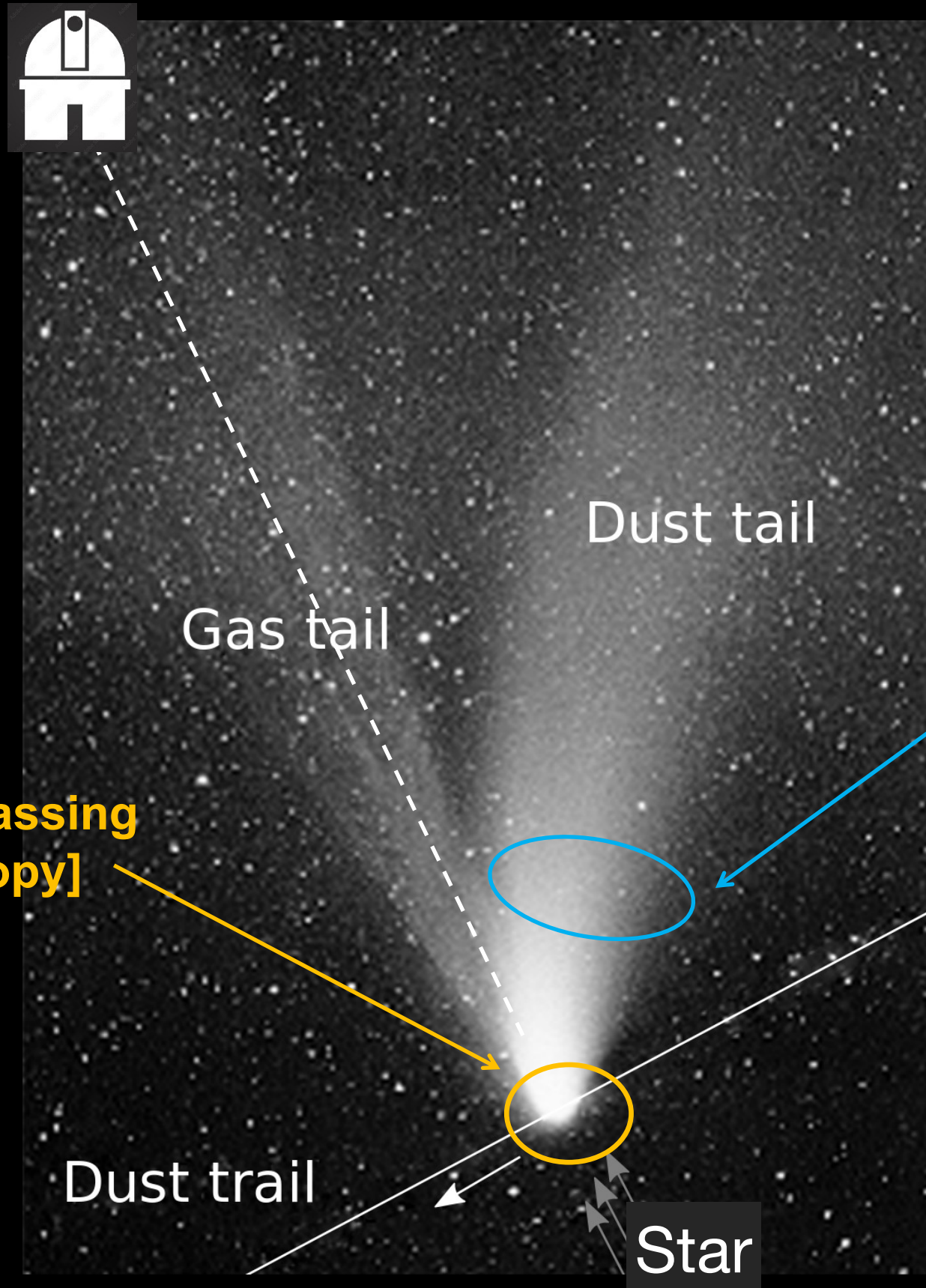


First report of exocomets: β Pic (Ferlet et al., 1987)

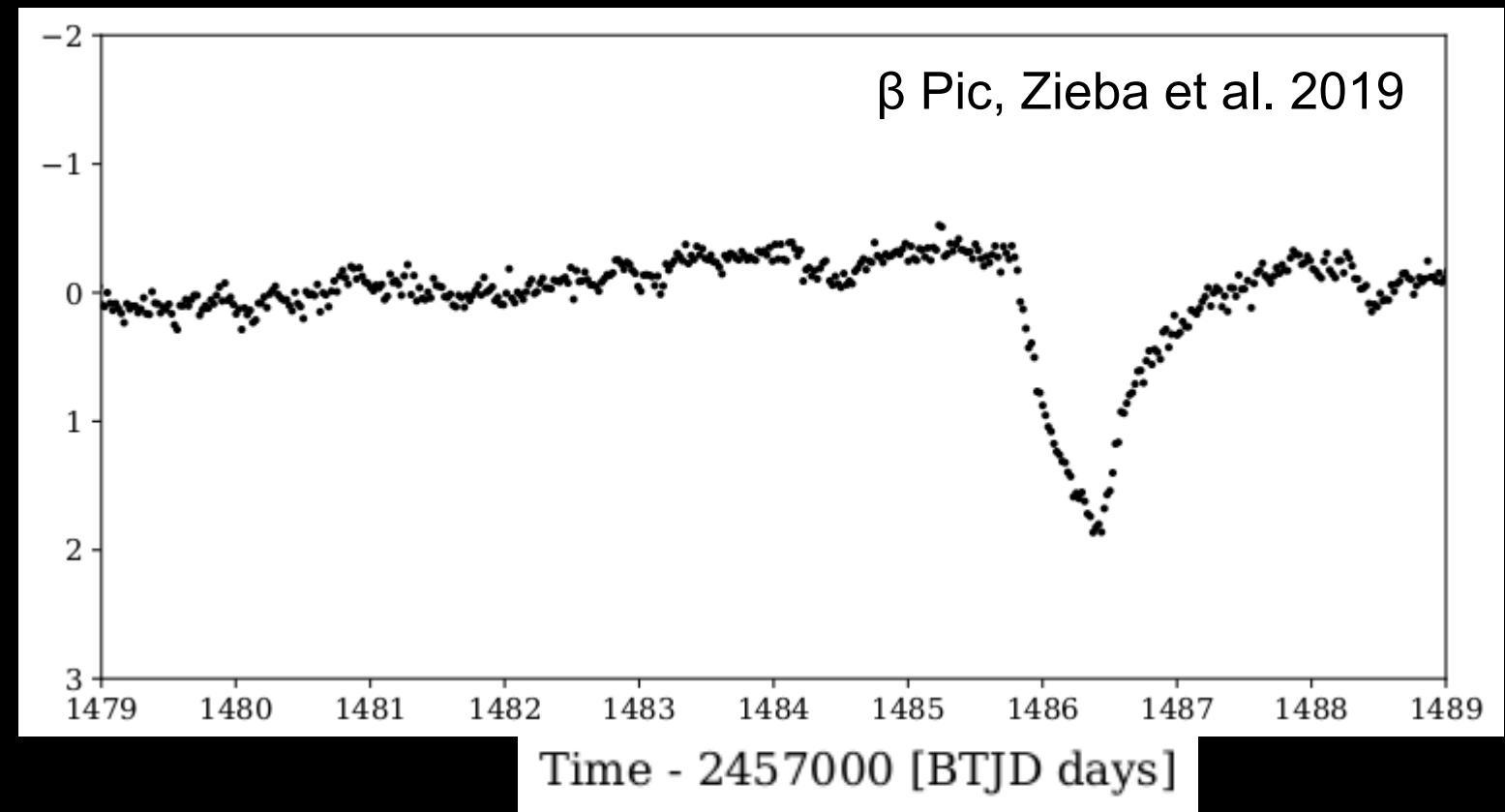


Two families of exocomets in β Pic (Kiefer et al., 2014)

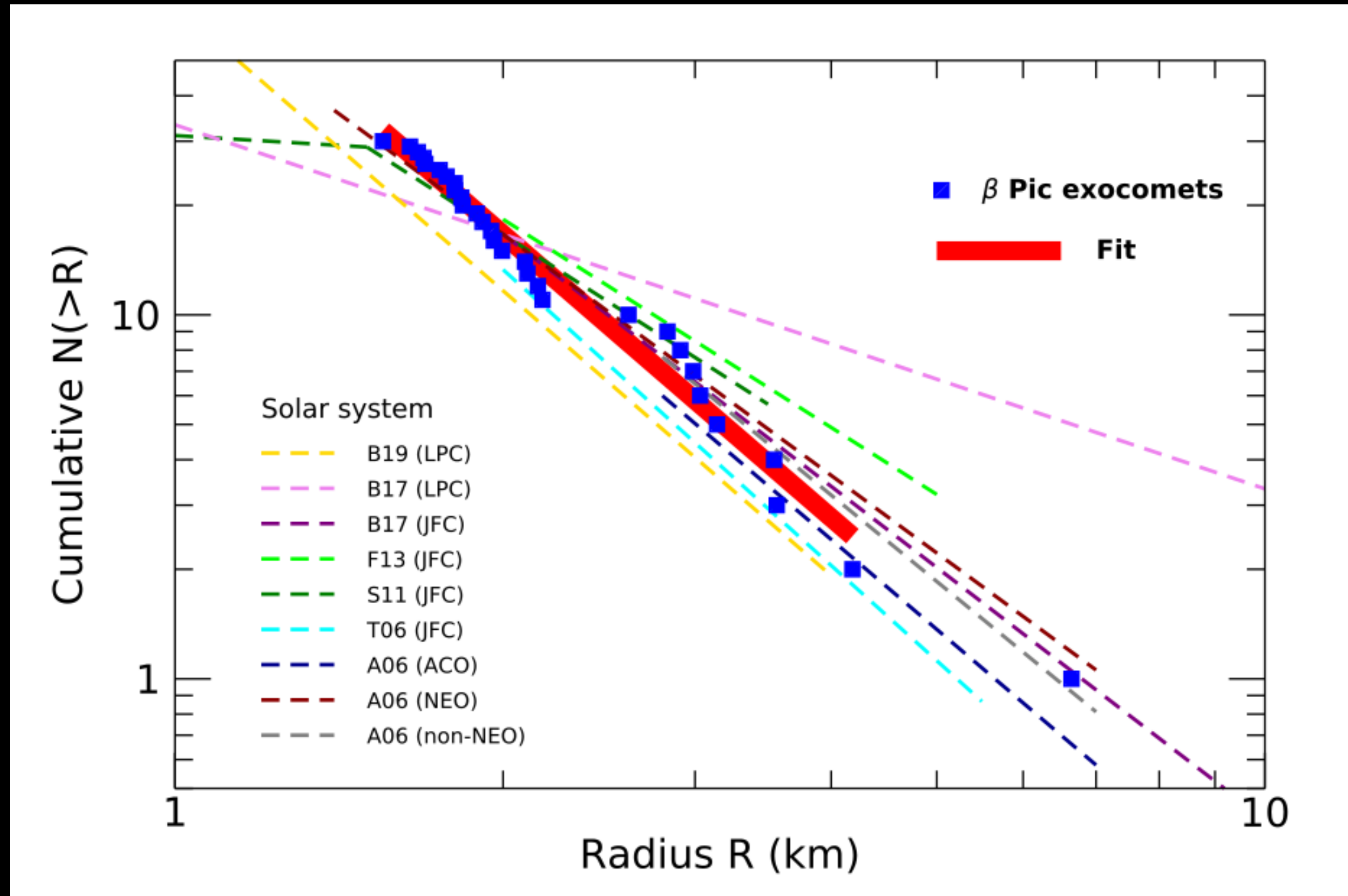
How to detect exocomets: photometry



Comet + dust
[transit photometry]

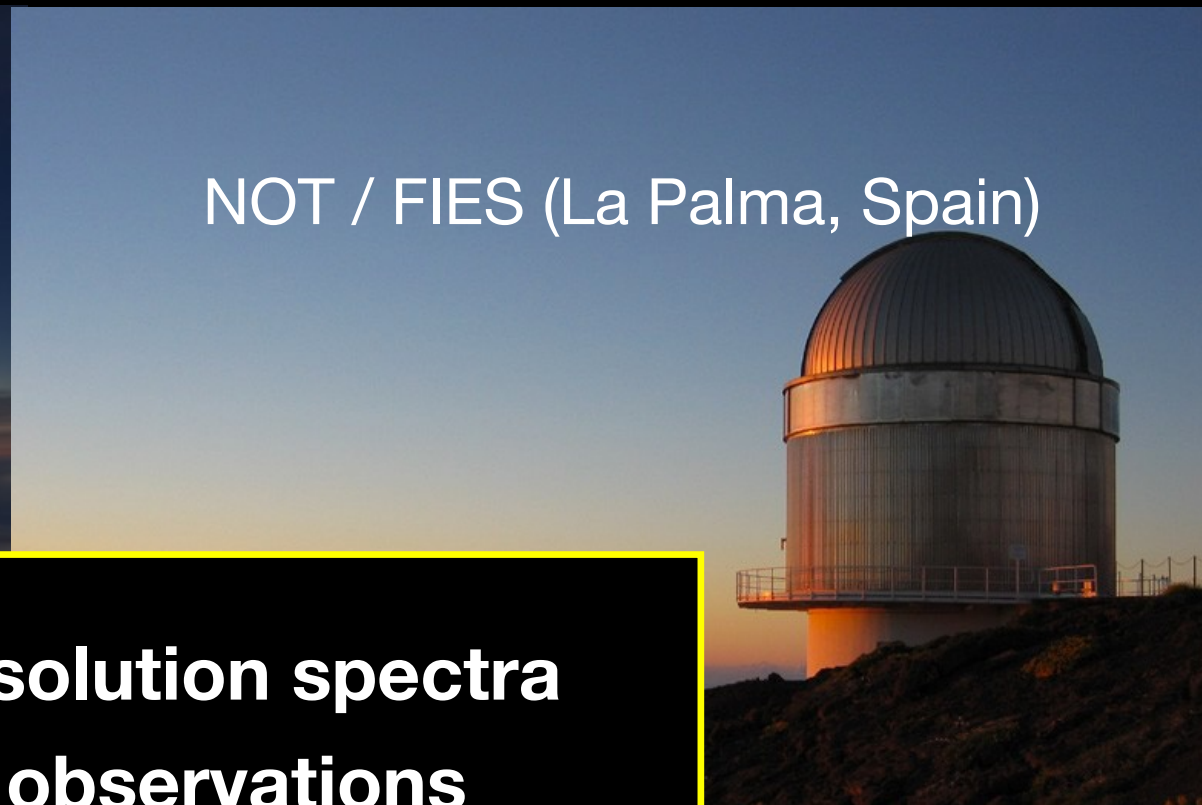


Sizes of exocomets in β Pic

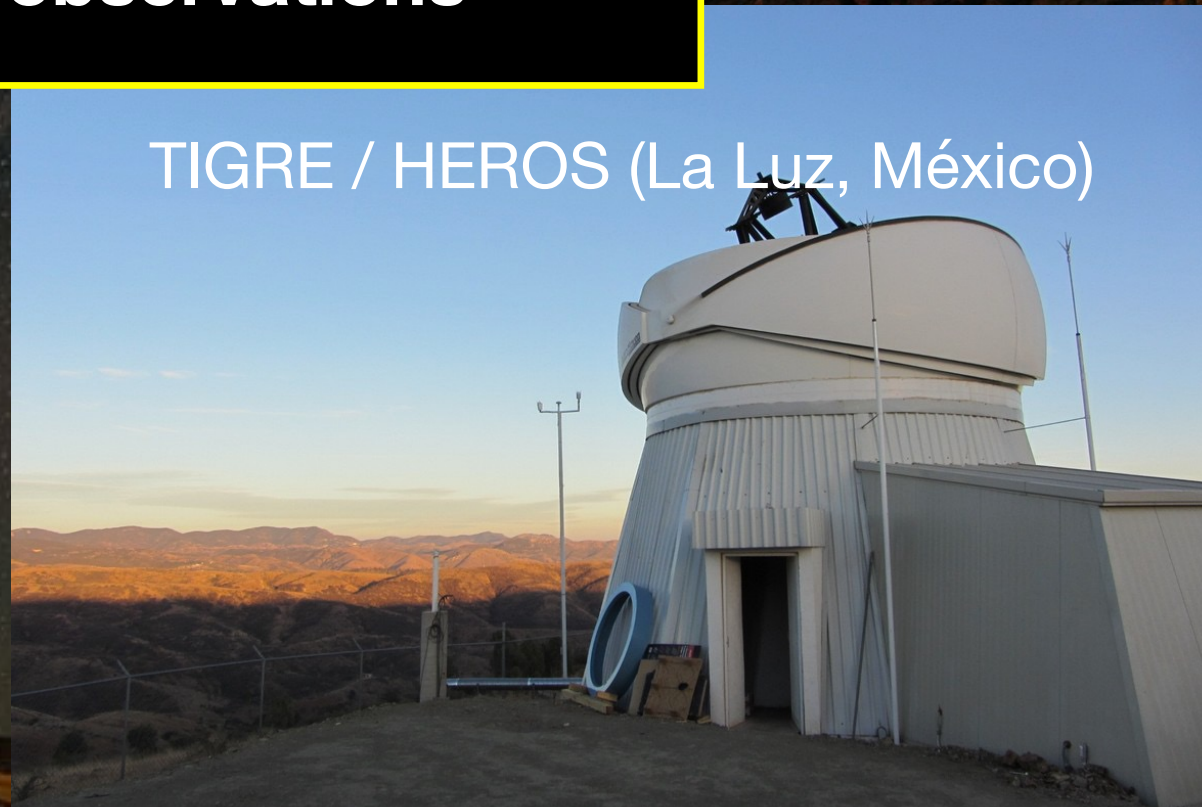


β Pic (Lecavelier des Etangs et al., 2022)

How to detect exocomets: our survey

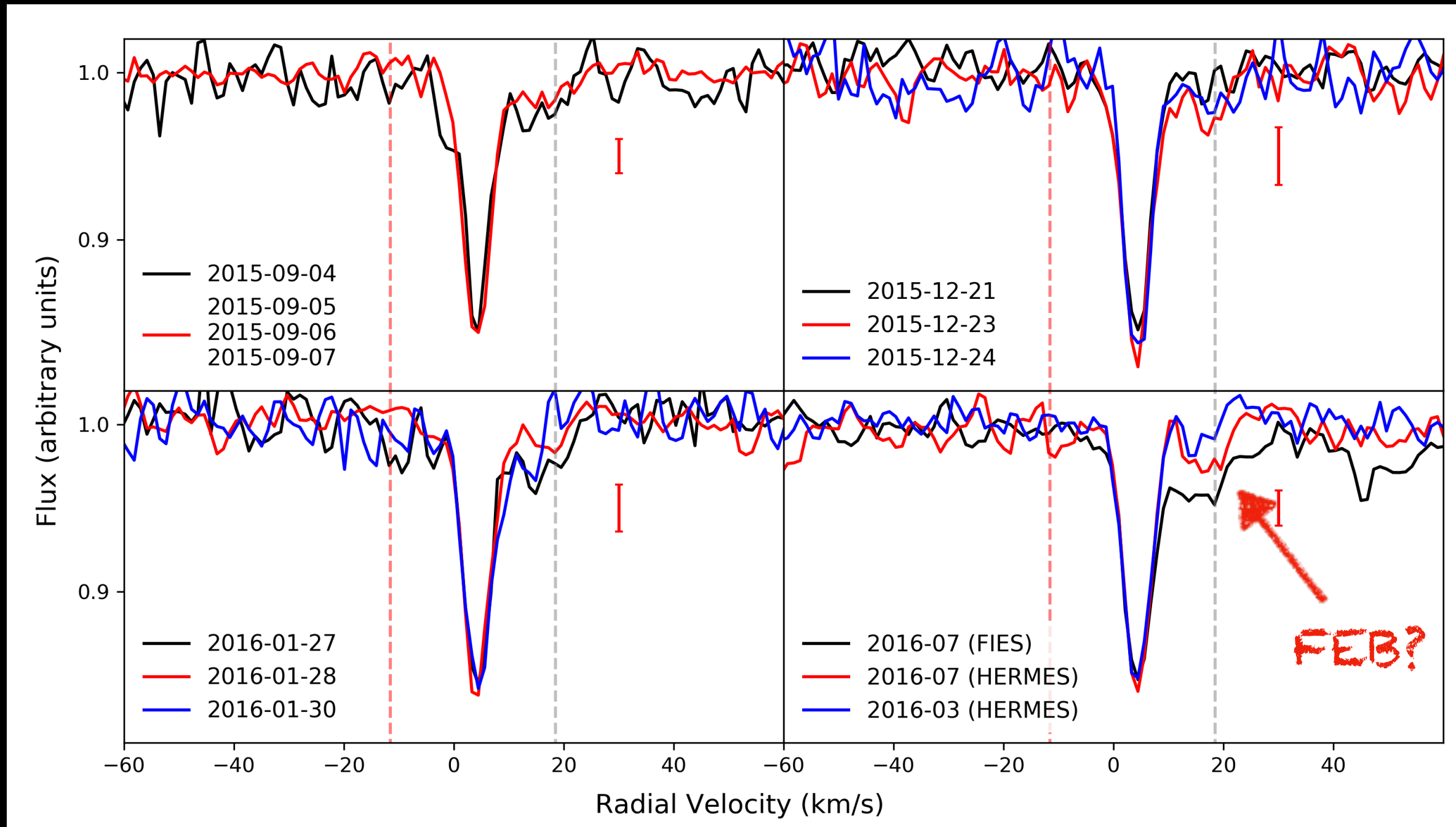


> 2000 high-resolution spectra
> 2 years of observations



How to detect exocomets: our survey

HD 21620 (A0 V, 80 Myr) Time series for variability detection

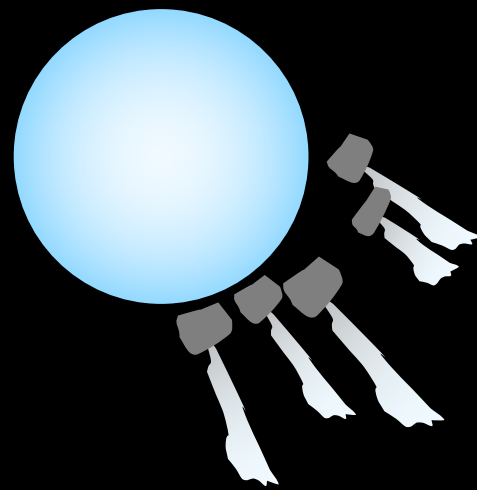


HD 21620 (Rebollido et al., 2019)

Results, and a -big- word of warning

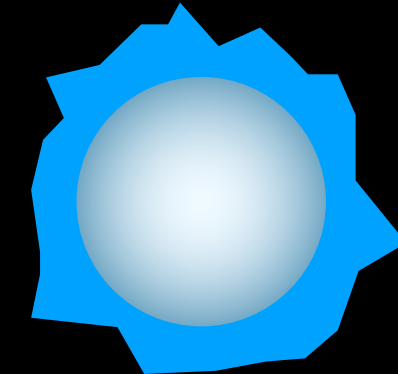
6 new potential candidates added to the list from our survey (Rebollido+2020, PhD Thesis)

BUT...



HR 10, one of the “paradigmatic” A-type stars showing cometary activity...

...after analyzing 30 years of observations (189 archive + own spectra + PIONIER/VLT), it is actually...



...a 750-d period binary whose components have individual CS envelopes, which are the origin of the observed variability... **No comets!!!** (Montesinos et al. 2019)

Ongoing project: monitoring campaigns to discover / confirm / discard exocomet-host stars