Two families of exocomets in the β Pictoris system

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Two families of exocomets in the β Pictoris system, **F. K.,** A. Lecavelier des Etangs, H. Beust, J. Boissier, A. Vidal-Madjar, G. Hebrard, A.M. Lagrange, R. Ferlet, *Nature (to be published soon)*

***Conference* 30 years of β Pictoris and debris disk studies**

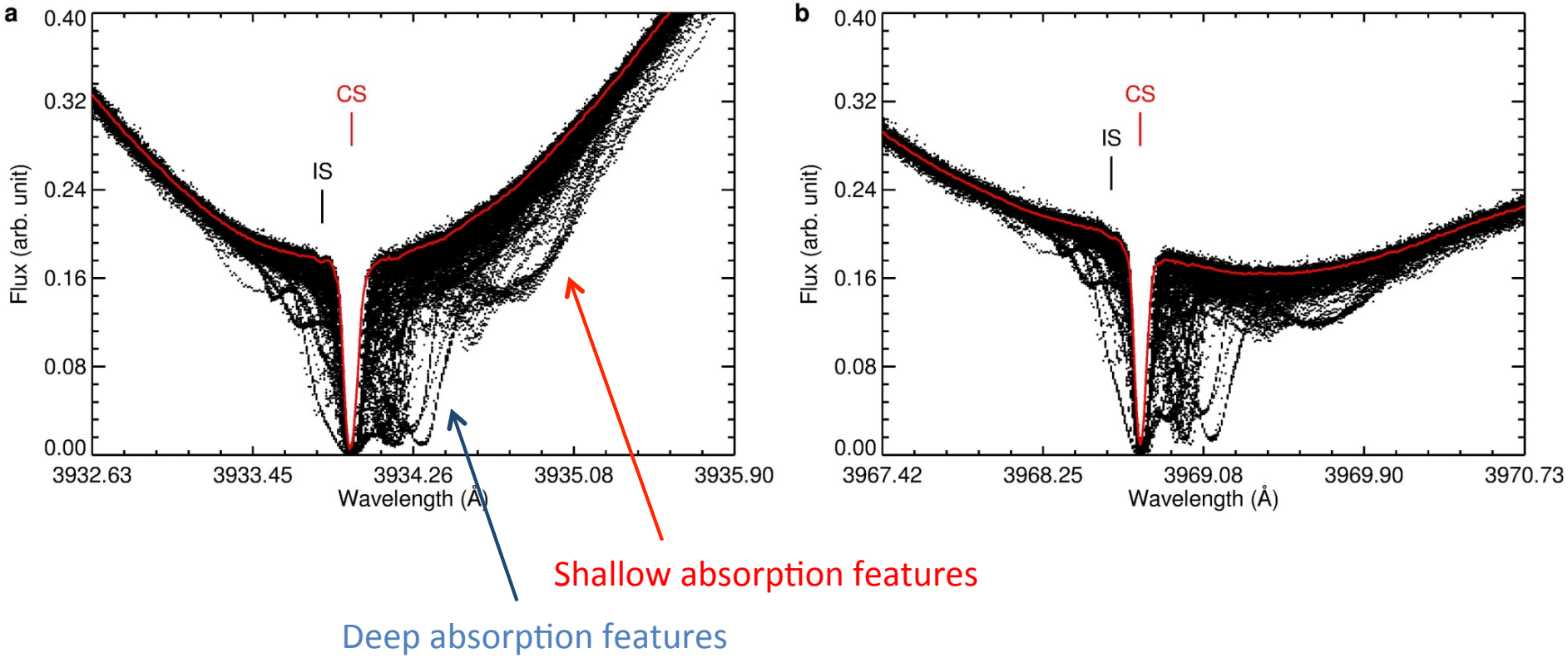
(Credit image NaCo)

Spectroscopic follow up of variable absorption features in the β Pictoris Ca II doublet with HARPS

- 1106 spectra collected with **HARPS** between 2003 and 2011,
- An average of 6 variable absorption feature detected per spectrum in Ca II doublet,
- A total of 493 individual exocomets identified.

Ca II K line ≈ 3934 Å

Ca II H line ≈ 3968 Å



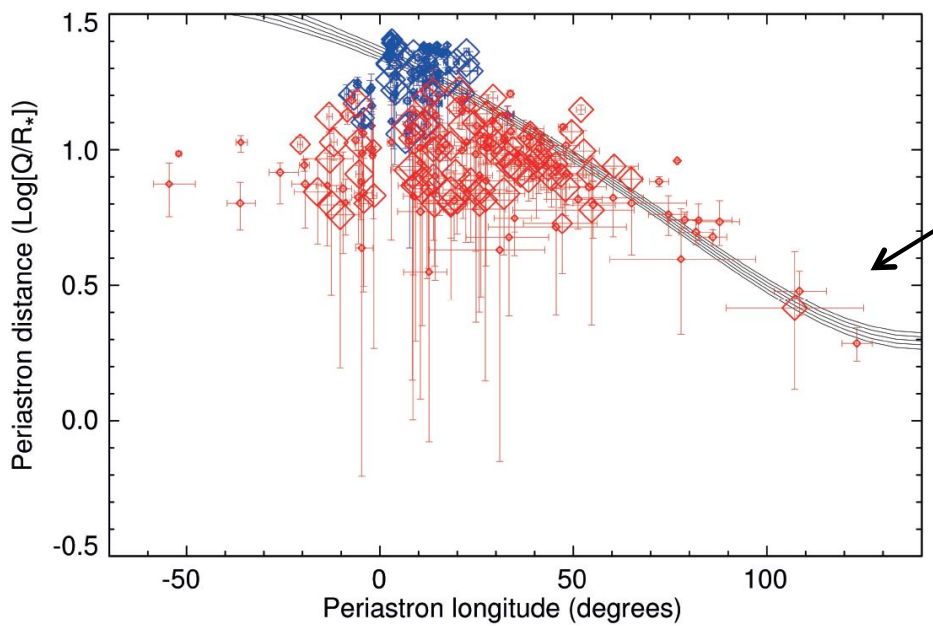
Two main types of detections

Shallow absorption features

- exocomets following orbits with a broad distribution of periastron,
- crossing the line of sight at less than 15R_*

Deep absorption features

- exocomets with enhanced evaporativity,
- following orbits with a narrow distribution of periastron,
- crossing the line of sight at more than 15R_*

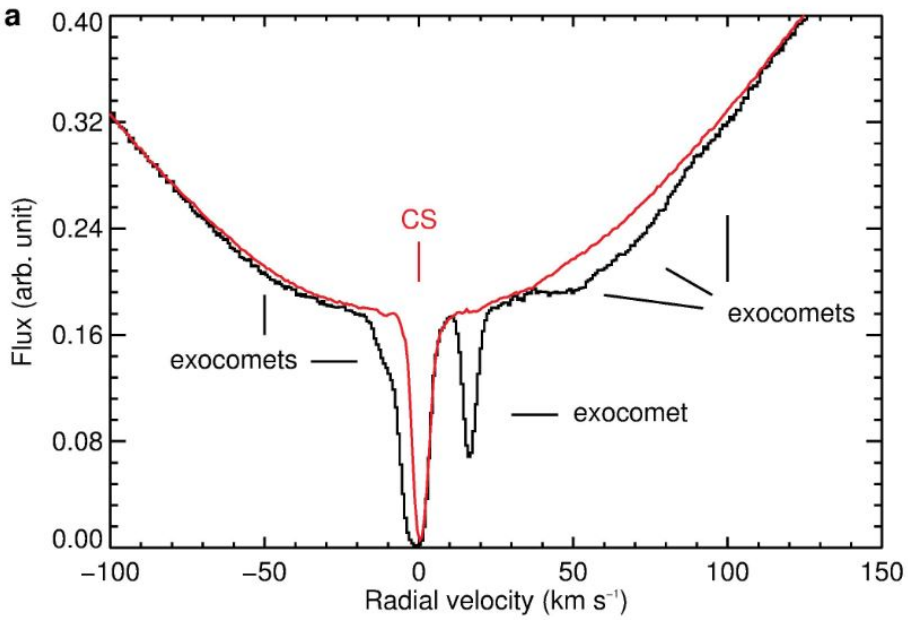


Mean-motion resonance pattern due to interaction with a jovian mass planet (β Pic b?)

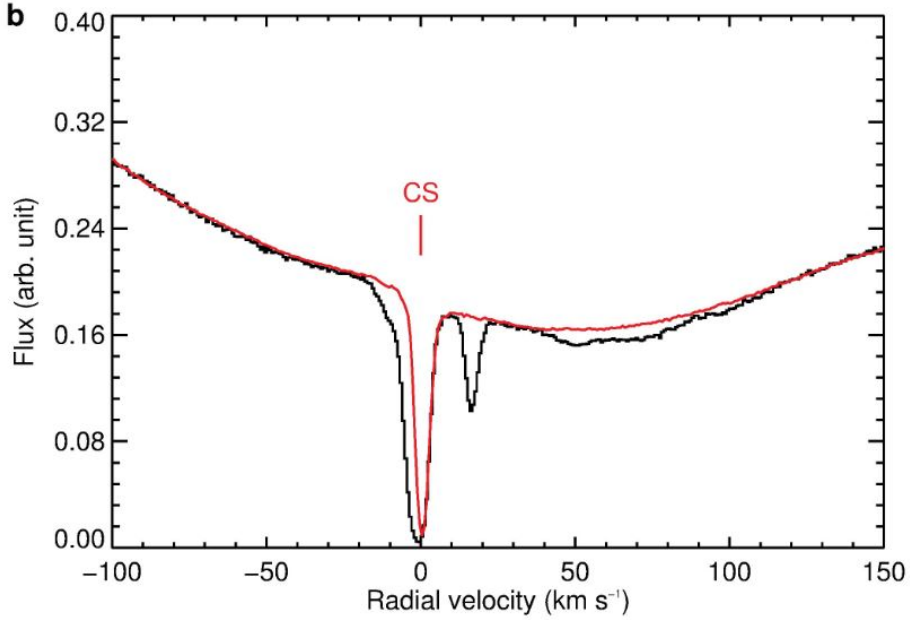
Beust and Morbidelli 1996

A Typical β Pic Ca II spectrum

Ca II K line



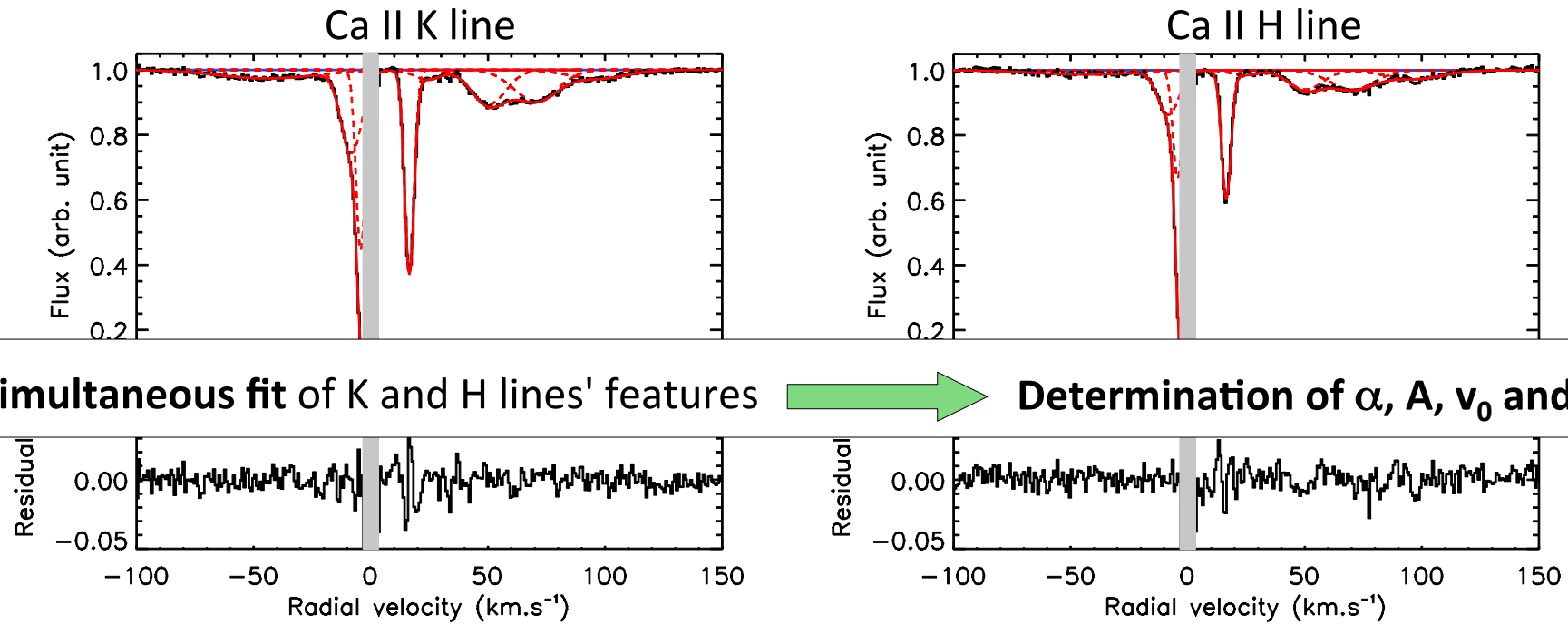
Ca II H line



Since 1987 (Ferlet et al.) these variable absorptions are interpreted by the transits of small ionic clouds in front of β Pic.

→ EXOCOMETS !

Normalized spectra and fit of variable features



Simultaneous fit of K and H lines' features → **Determination of α, A, v_0 and σ**

Gaussian profile: $p_K e^{-(v-v_0)^2/2\sigma^2}$ $p_H e^{-(v-v_0)^2/2\sigma^2}$

Eclipsing clouds: $p_K = \alpha(1-e^{-A})$ $p_H = \alpha(1-e^{-A/2})$

Surface ratio

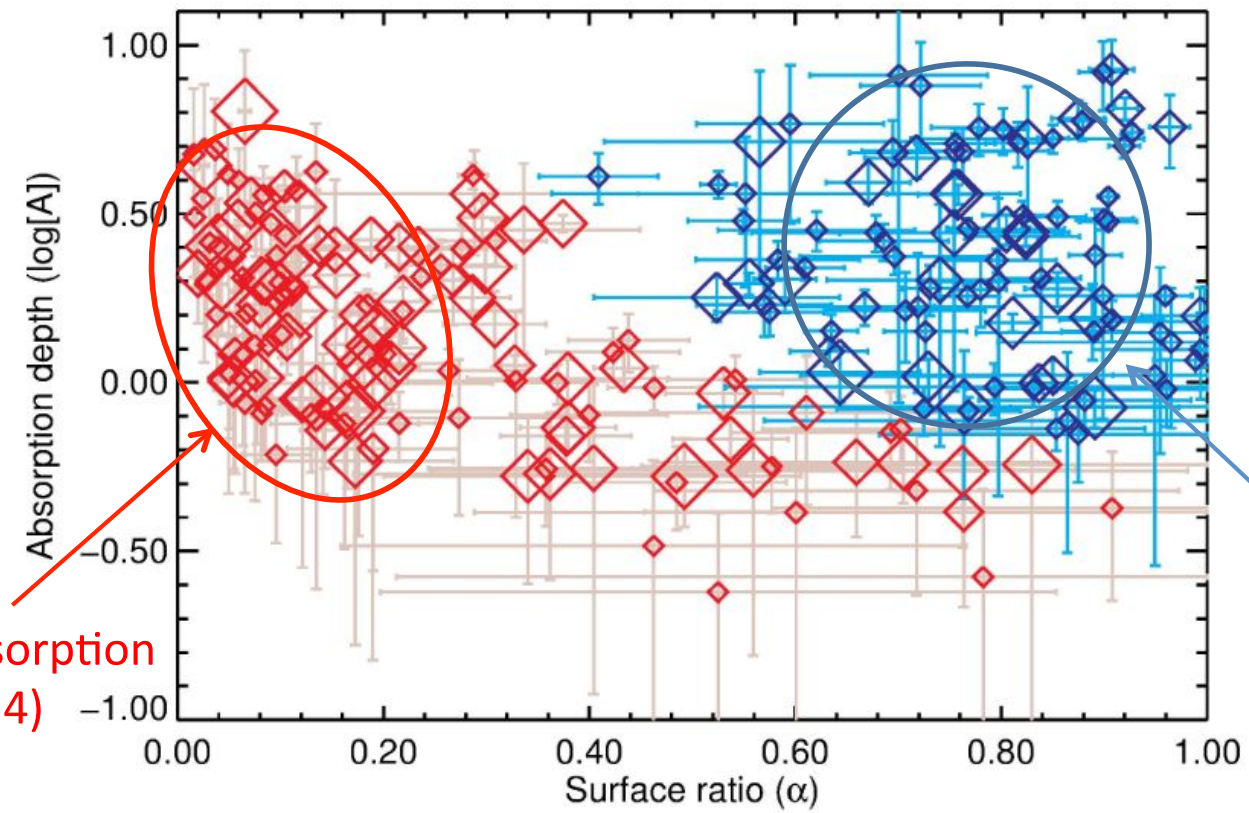
$\alpha = \Sigma_c / \Sigma_*$

Absorption depth
= Optical depth at v_0

493 individual detections of independent exocomets

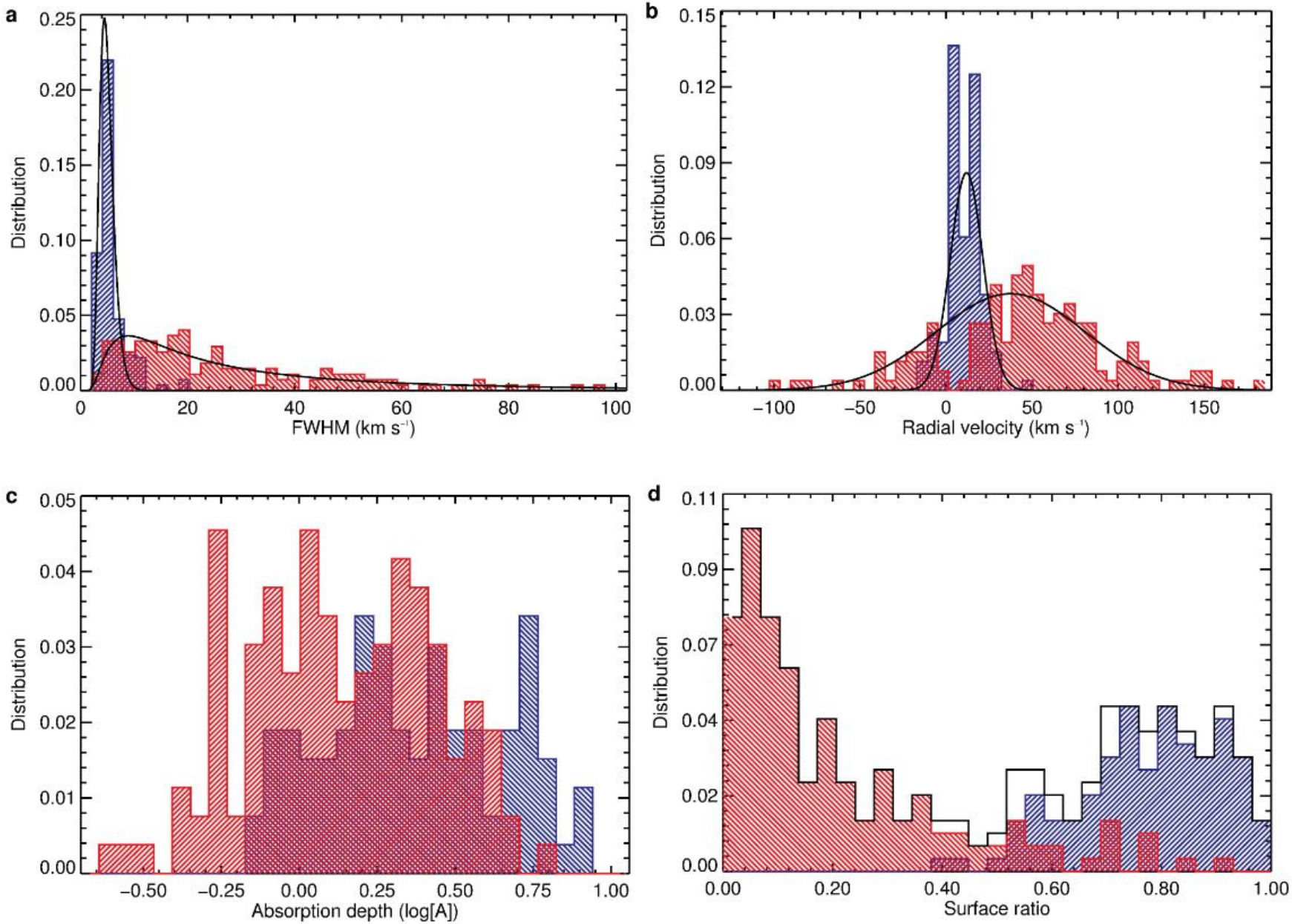
Between each selected spectrum
$\Delta t > 1$ day

1 detection = 1 exocomet

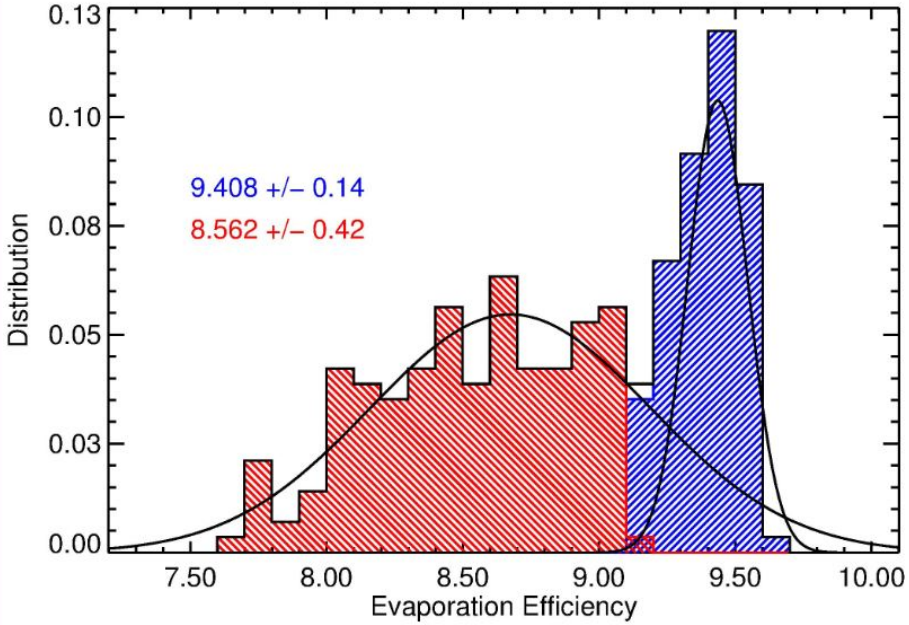


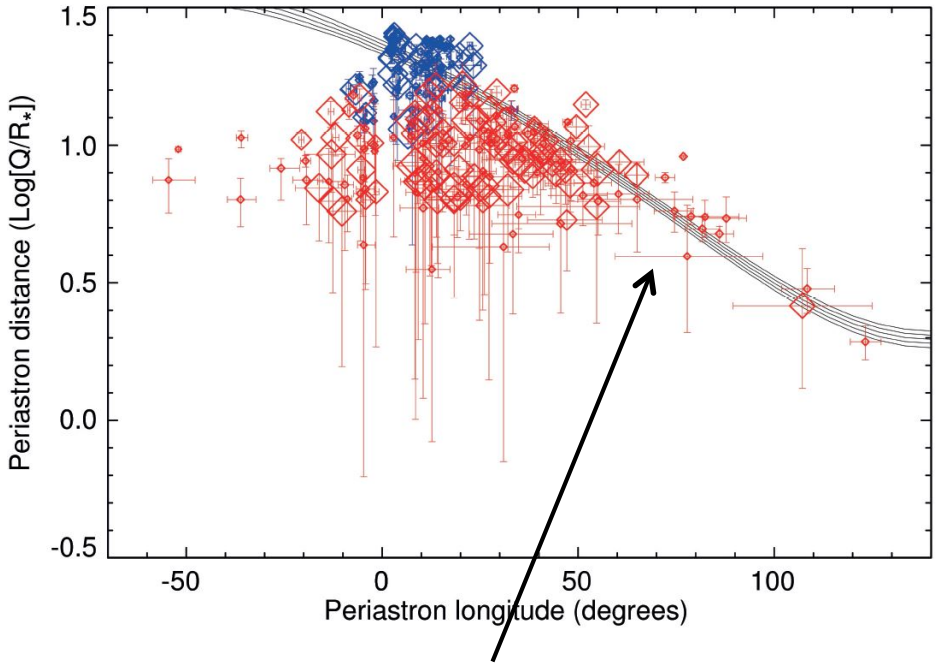
Shallow absorption lines ($p_K < 0.4$)

Deep absorption lines ($p_K > 0.4$)


a
Distribution
FWHM (km s⁻¹)
b
Distribution
Radial velocity (km s⁻¹)
c
Distribution
Absorption depth (log[A])
d
Distribution
Surface ratio

Physical parameters of each family of exocomets



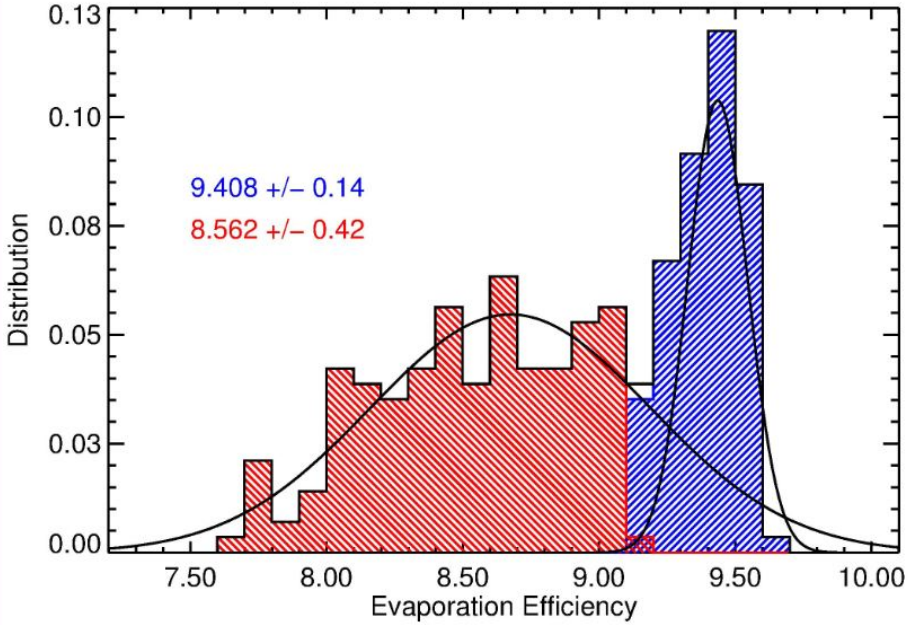


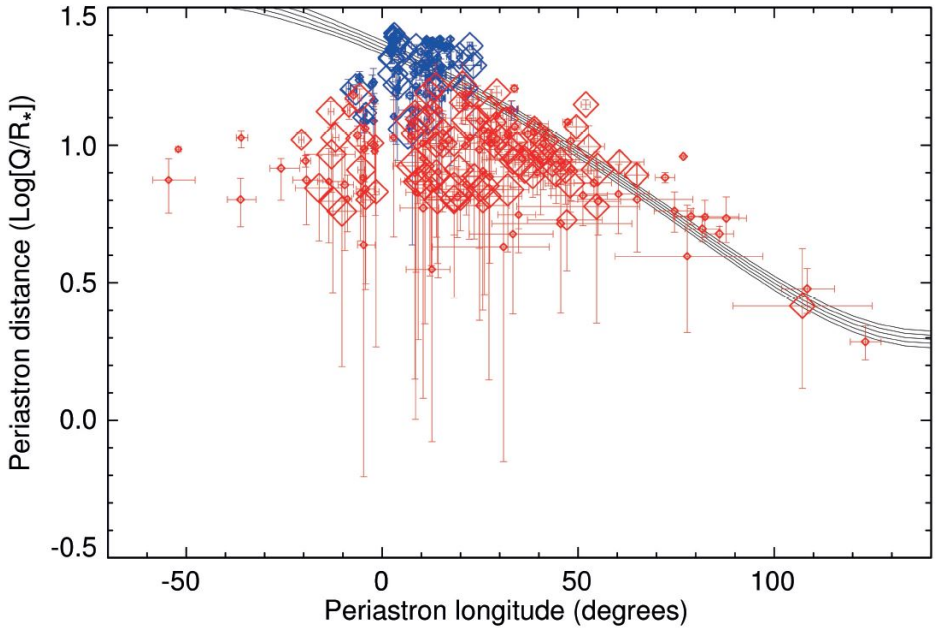
4:1 mean-motion resonance evolution curve computed by H. Beust for the interaction of small bodies with a $10M_J$ planet at 5AU.

$$Evap.\ eff. = \mathrm{Log}\, Energy\ used\ for\ evaporation / Incident\ stellar\ flux$$

$$= \log L_H\, O\, Z_H\, O + M\, v^2 / 2 / F_*(a)$$

Conclusions





Difference of evaporation efficiency:

➔ Shallow absorptions generated by aged comets,

➔ Deep absorptions generated by fresher comets.

Difference of orbits:

➔ Aged comets influenced by resonance mechanism,

➔ Fresher comets as fragments from the disruption of one or a few parent bodies (*like* the Kreutz family in the Solar System)

Thank you for your attention!