Testing the exocometary bow shock model by analyzing the variability in the Al III line around Beta Pictoris

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Abstract

- Exocomets **sublimate** close to the stars, causing the metallic atoms to ionize and showing **variable redshifted and blueshifted absorption lines.**
- **Beta Pictoris is a young, bright star** with an enormous exocometary activity. However, is surprising that it shows the highly ionized **Al III,** as **the star itself is unable to photoionize it.**
- One hypothesis is that exocomets generate a **bow shock at d ≲ 5 R*** (*Beust & Tagger 1993*) when they are sufficiently close to the star, which lead to **collisions capable of ionizing Al III.**

Is the Al III really forming at d ≲ 5 R*? Or could it form further away?

1. Method

Look for variations of the radial velocity from the Al III absorption line

⬇

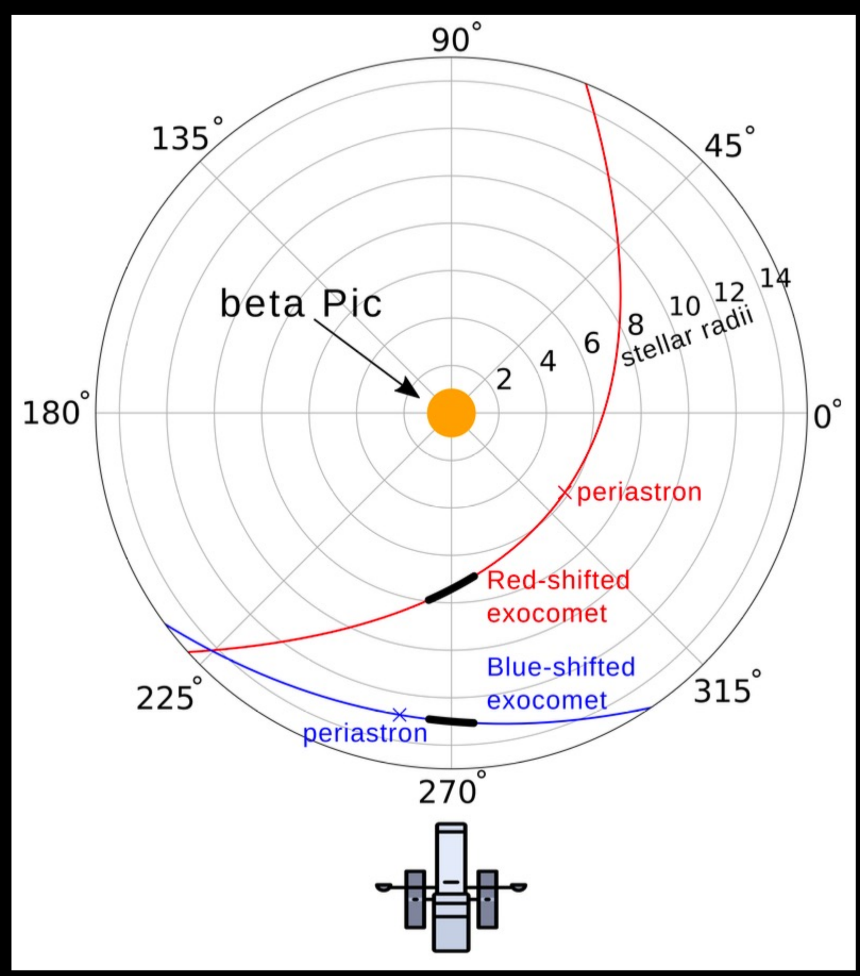
Measure the acceleration (Newton's law $a = \frac{GM}{r^2}$)

⬇

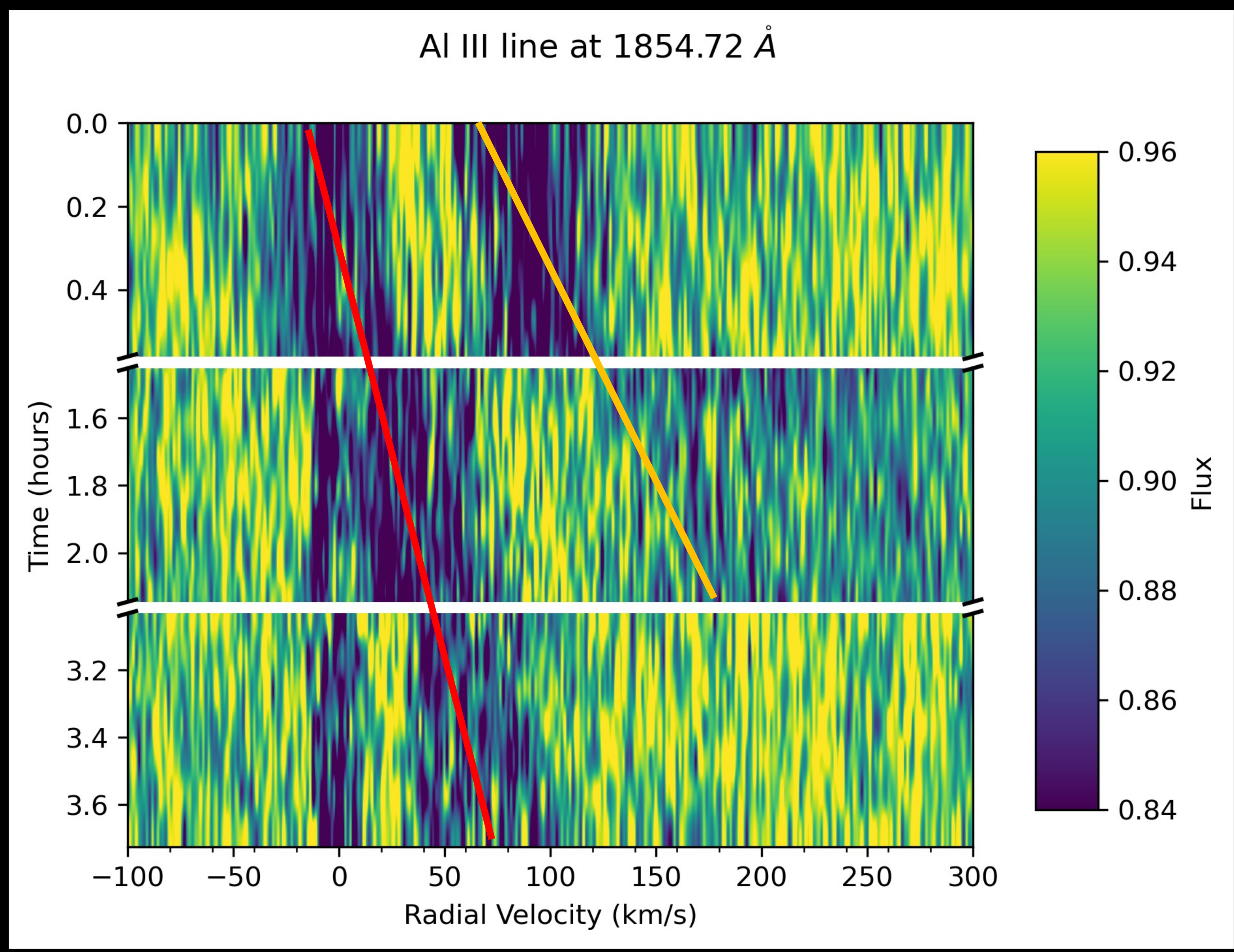
Know the distance to the star of the exocomets

⬇

Characterize the bow shock and test the hypothesis by analyzing 3 visits of the star made by Hubble.



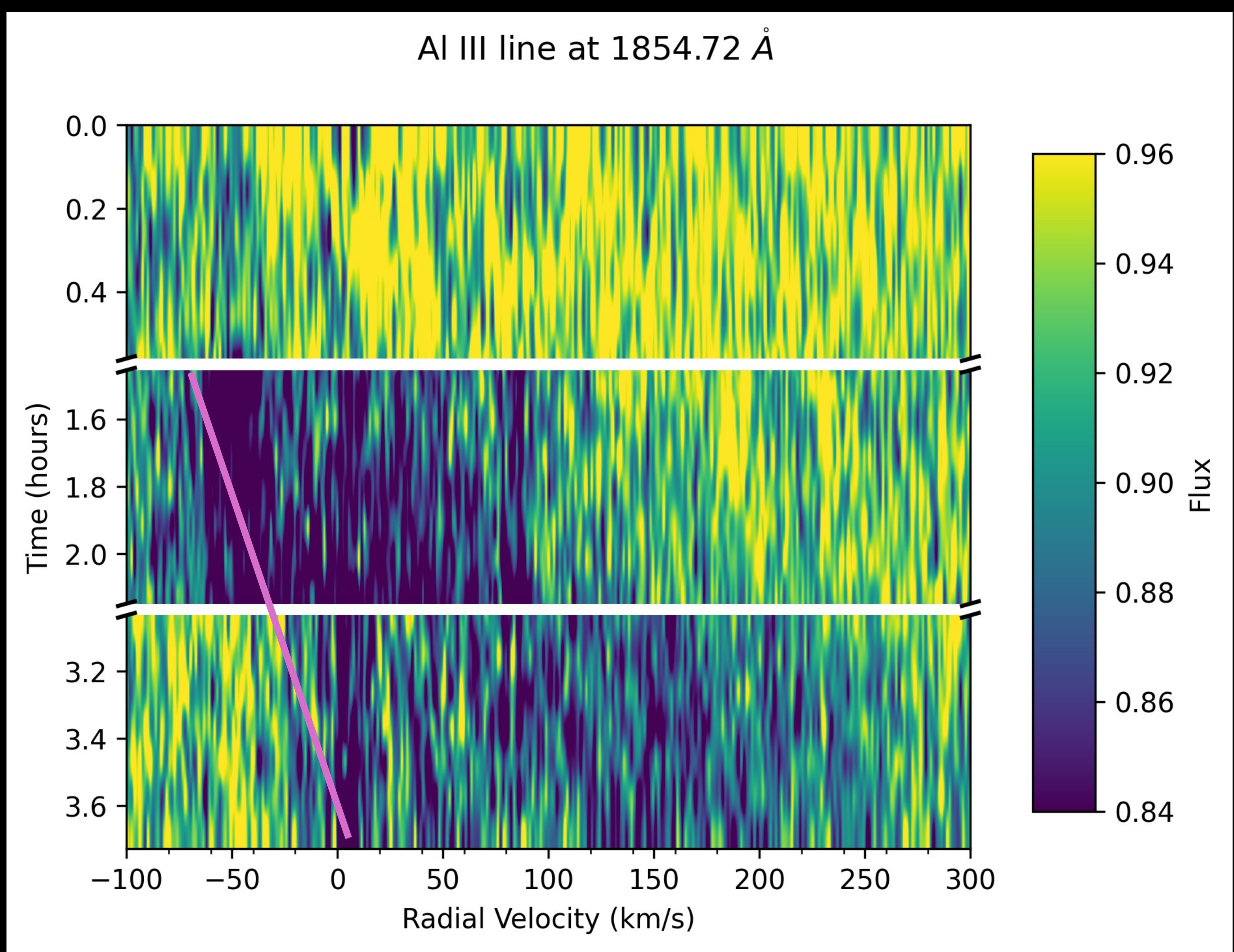
2. Hubble observations. Visit 1: 17th April 2024



2 exocometary features

- ~0 km/s - ~100 km/s → d = 5.9 ± 0.6 R*
- ~70 km/s - ~170 km/s → d = 3.1 ± 0.6 R*

Visit 2: 31st July 2024



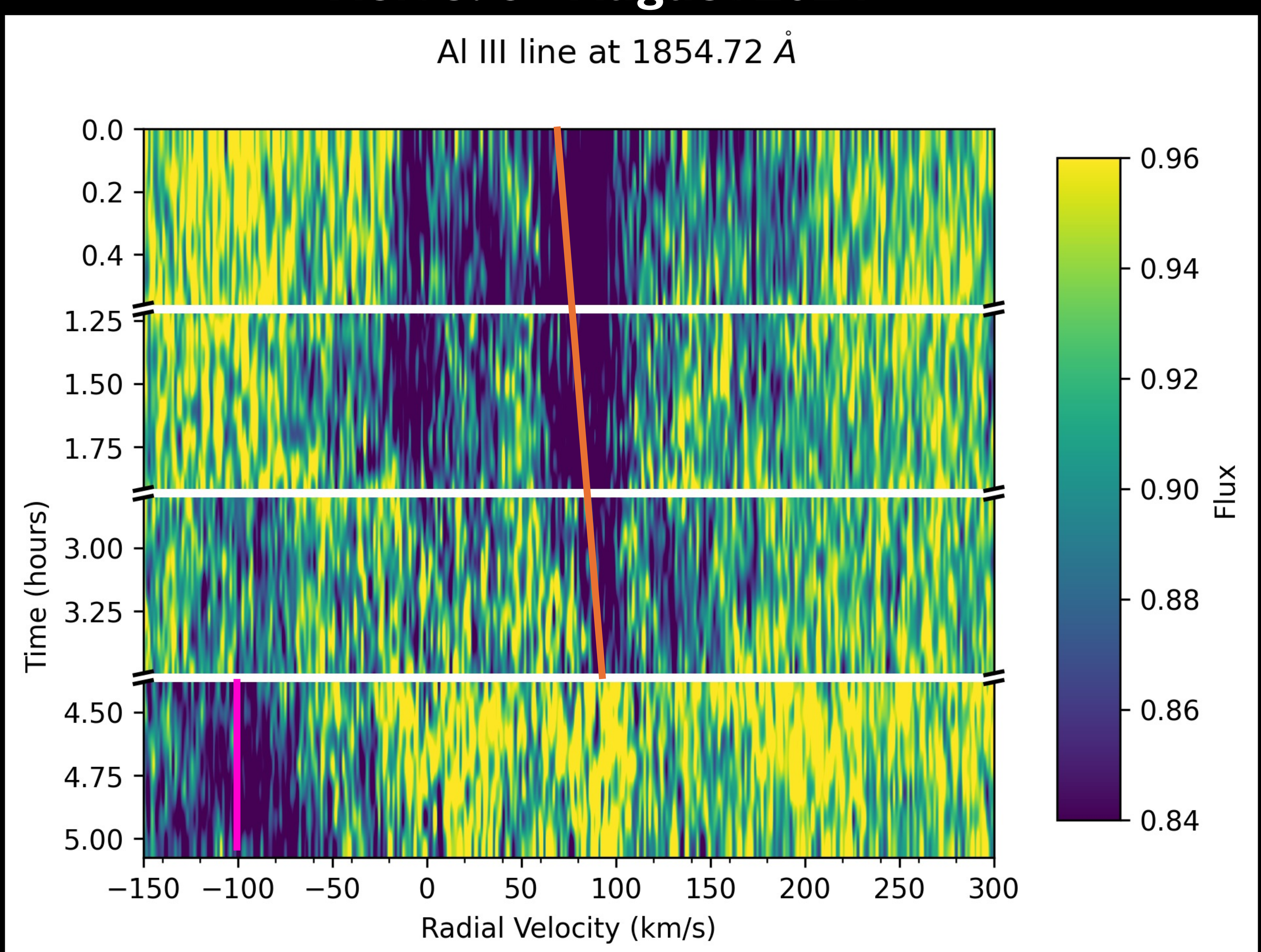
The **range of velocities** for each feature is **due to the size and geometry** of the exocomets (coma and tail).

One feature could be **one exocomet, or a chain of several** of them.

1 exocometary feature

~-60 km/s – 0 km/s → d = 4.1 ± 0.9 R*

Visit 3: 8th August 2024



2 exocometary features

- ~90 km/s - ~100 km/s → d = 15.2 ± 2.3 R*
- ~-100 km/s

3. Conclusions

✓ We have **confirmed variability in the Al III** line, due to exocomets

✓ We **know the distance** at which the exocometary features are from the star

✓ We have shown that **Al III forms further from the star than previously thought/predicted.**

Future work:

- We are working on **comparing this analysis with that of Ca II** in the optical (it helps revealing if the features are made by one or more exocomets).
- We can study the **radial composition of the shock front** by analyzing other lines of species like **Al II, Fe II, Si II**