New observations of the β Pictoris b exoplanet

Mickaël Bonnefoy[1]

A.-M. Lagrange[2], A. Boccaletti[3], G. Chauvin[1,2], D. Apai[4], D. Ehrenreich[2], F. Allard[5], J. Girard[6], D. Mouillet[2], D. Rouan[3], D. Gratadour[3], & M. Kasper[6]

[1]Max Planck Institute For Astronomy (Heidelberg, Germany) • [2]Institut de Planétologie et d'Astrophysique de Grenoble (Grenoble, France)
[3]Observatoire de Paris (Meudon, France) • [4]Space Telescope Science Institute (Baltimore, USA) • [5]CRAL-ENS (Lyon, France)
[6]European Southern Observatory (Santiago, Chile & Garching, Germany)

Abstract: Since the identification of its extended debris disk 26 years ago, the young (8-20 Myr) and A6 star β Pictoris has become a reference target for the study of planetary formation processes. In fall 2010, we imaged a planetary mass companion at 3.8 μm (L' band) inside the disk, bringing the proof that extrasolar planets can form in a few Myr. We present here new observations of β Pictoris b at 2.18 μm (Ks-band). These observations provide a new mass estimation for the companion and enable to estimate its effective temperature. The characteristics of the β Pictoris system put precious constraints on the current generation of evolutionary models.

1 - Observations & data analysis

Observations were performed with the VLT/NaCo instrument on March and April 2010. NaCo was operated with the angular differential imaging mode (ADI). Data were reduced using custom tools based on the smart-ADI (Marois et al. 2006) and LOCI (Lafrenière et al. 2007) algorithms. The planet was retrieved in each datasets and for each given reduction algorithm (see the right panel of **Figure 1**).

The ADI data processing tend to self-subtract some of the companion flux. We have estimated these flux losses injecting a negative artificial planet at the companion location. This novel method was also used to retrieve simultaneously the position of the planet. It is only sensitive to the local level of residuals and provides accurate photometric estimations (down to ~0.1 mag).

2 - Astrometry

The planet is found ~50 mas away from the fall 2010 position (see **Figure 1**). This agrees with the Quanz et al. 2010 results (see the talk by S. Quanz) and with the expected motion of a 8 M_{jup} body on a 8-15 AU low-exentricity orbit.

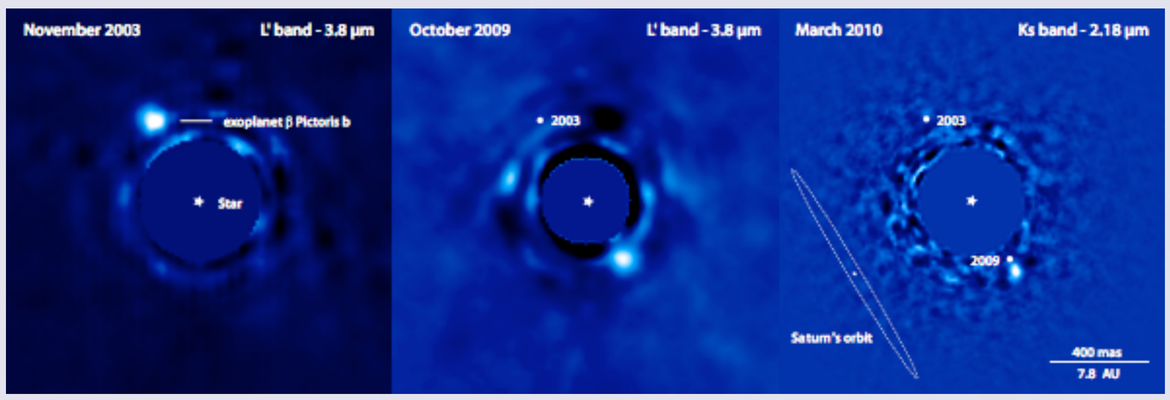

Figure 1

Any questions left?

I should be around

Otherwise, feel free to pick up some printed versions of my article (**Bonnefoy et al. 2011, A&A**) and/or to contact me: *bonnefoy@mpia.de*

3 - Spectral type & effective temperature

We find a Ks-L' color of 1.43±0.19 mag for β Pictoris b. This color is compatible with those of L1-T0 field dwarfs (**Figure 2**). This spectral type range is consistent with that derived by Quanz et al. from the L'-4.05 μm color. Our spectral type estimations could be however biased given the atypical red colors noticed for late-type and young (< 100 Myr) objects.

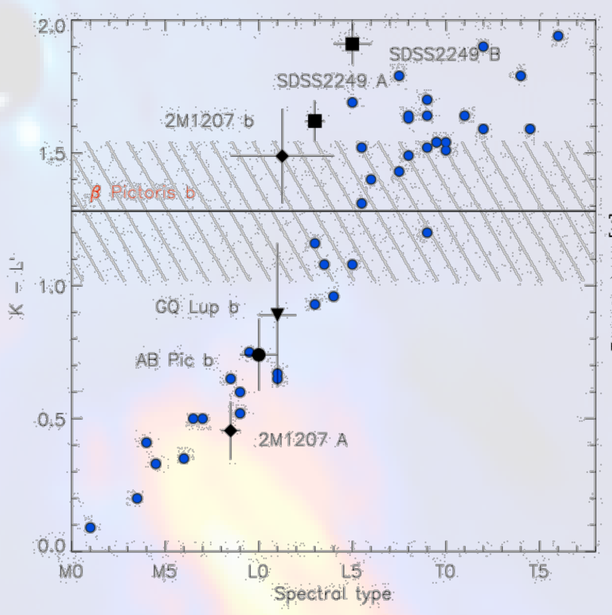

Figure 2

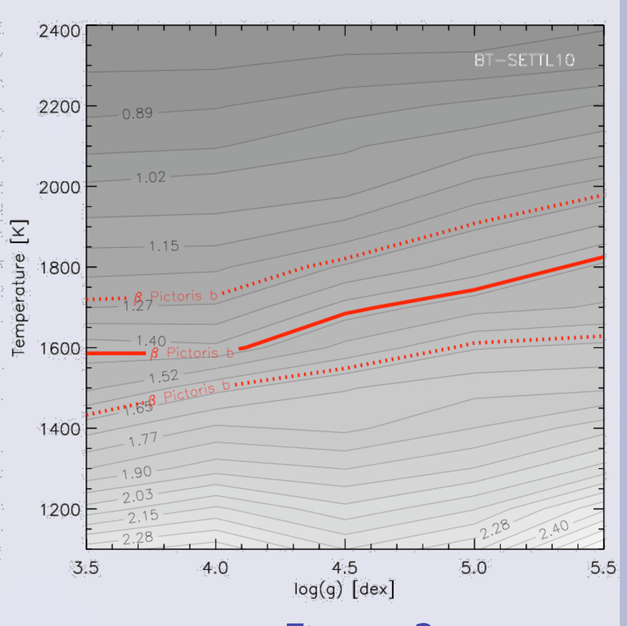

Figure 3

The color was also compared to those generated using the BT-SETTL10 atmospheric models (Allard et al. 2010). This constrain the T_{eff} to 1400-2000 K but does not enable to derive the surface gravity (**Figure 3**).

4 - Conclusions

The T_{eff} and fluxes of Beta Pictoris b, are consistent with those predicted by the *hot-start* evolutionary models - where all the gravitational energy is converted into head during the formation process (collapse of a cloud) - for a 7-11 Mjup object. On the contrary, the recent *cold-start* evolutionary models - where the energy produced during the gas accretion process is fully released - fail to predict masses in agreement with the dynamical constraints brought by the system.

Future spectra collected with the planet imagers (GPI, SPHERE) should enable to further characterize β Pictoris b.