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mission control

Looking for rings and things

It's not often that an astronomical object gets its own dedicated observatory, but as the planet Beta Pictoris b moves in front of its host star, its every move will be watched by bRing, eager to discover more about the planet's Hill sphere, explains **Matthew Kenworthy.**

It's called the Plateau, a hundred acres of flat red rock and dust dotted with over a dozen telescope domes, some six hours drive from Cape Town. It's home to one of the largest telescopes in the world, and also now to one of the smallest, standing alone and facing due south. The Beta Pictoris b Ring project (bRing for short) consists of two small washing-machine-sized observatories in the Southern Hemisphere, one to be installed in Siding Spring, Australia by the University of Rochester, and the other has recently been commissioned at the South African Astronomical Observatory near Sutherland in the Karoo Desert (Fig. 1).

Our goal is to watch the bright Southern Hemisphere star Beta Pictoris throughout 2017 and early 2018 as an exoplanet some twelve times more massive than Jupiter (called Beta Pic b) moves between us and its parent star. Images from some of the largest telescopes in the world have directly imaged Beta Pic b, tracking its orbital motion from year to year. The almost circular orbit is seen nearly edge-on to our line of sight on Earth, and the latest images show that although the planet will not move in front of the disk of the star itself, the Hill sphere of the planet will[1].

The Hill sphere is the volume where dust and gas orbit the planet instead of the star. In 1981, flux measurements showed a gradual brightening and dimming of the star over a two-week period, centred on a three-day period where the star appeared to fluctuate by about 6% of its peak brightness[2]. Several hypotheses for this variability were put forward, including the transit of cometary clouds and a giant planet with rings like Saturn's. Now we know that the planet did not cause the 1981 event[1], the strongest hypothesis is the transit of circumplanetary dust or gas, possibly sculpted by the presence of moons into ring-like structures.

The transit of Beta Pic b's Hill sphere takes about 300 days, starting in April 2017 and ending sometime at the beginning of 2018. In order to monitor Beta Pictoris we started the bRing project at Leiden Observatory and the University of Rochester. Building on Leiden's expertise in building an all-sky camera project called MASCARA[3], we designed, built and tested a fully contained robotic monitoring station that uses two wide-angle commercially-available camera lenses, pointing in two fixed directions, to cover the complete track of Beta Pictoris as it rises and sets in the southern skies.

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Figure 1 | The bRing observatory at the South African Astronomical Observatory near Sutherland, South Africa.

The bRing station was shipped to South Africa in January 2017 and commissioned successfully over the course of two weeks. Every clear night at sunset two shutters open and the two cameras start taking images every 6 seconds throughout the entire night. The data are too large to send back to Leiden, so two computers inside bRing analyse and send us the data pertaining to Beta Pictoris, along with all the other stars that pass through bRing's field of view.

If (or more optimistically, when!) we see the distinctive change in the light curve of Beta Pictoris, we will trigger spectroscopic observations using some of the world's largest telescopes. They will look for the spectral fingerprints identifying the composition of the material orbiting the planet. The fluctuations of the starlight can also determine the large-scale structure of the material, using a technique performed by our team when looking at the young star J1407, where we detected giant Hill sphere-filling rings up to 200 times larger than Saturn's rings[4,5]. Beta Pictoris may well harbour a similar type of system.

All the gas giant planets in our Solar System have rings of varying compositions around them, along with a retinue of regular satellites most likely formed from the remains of circumplanetary disks. Their study with interplanetary probes has allowed us to understand this era in the Solar System. With the discovery of exoplanets, we now have the opportunity to search for exorings and, indirectly, the presence of exomoons through their influence on the light from their parent star.

On the last night of our installation, a 70 km h^{-1} wind whipped the red dust across the Plateau, and we huddled over the exposed cameras, waiting for the last of the twilight to leave the sky so that we could do our final calibration and focusing tests. Shivering in our many layers of clothing, we bolted the hood firmly in place and retreated into a nearby control room to warm up again. bRing now sits alone, with only the South African night sky and the odd springbok for company.

bRing is a collaboration between Leiden Observatory (M. Kenworthy, R. Stuik, J. Bailey III, G-J. Talens, P. Dorval and I. Laginja), the South African Astronomical Observatory (S. Crawford and B. Lomberg), the University of Rochester (E. Mamajek and S. Mellon) and the Australian National University (M. Ireland). ❐

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