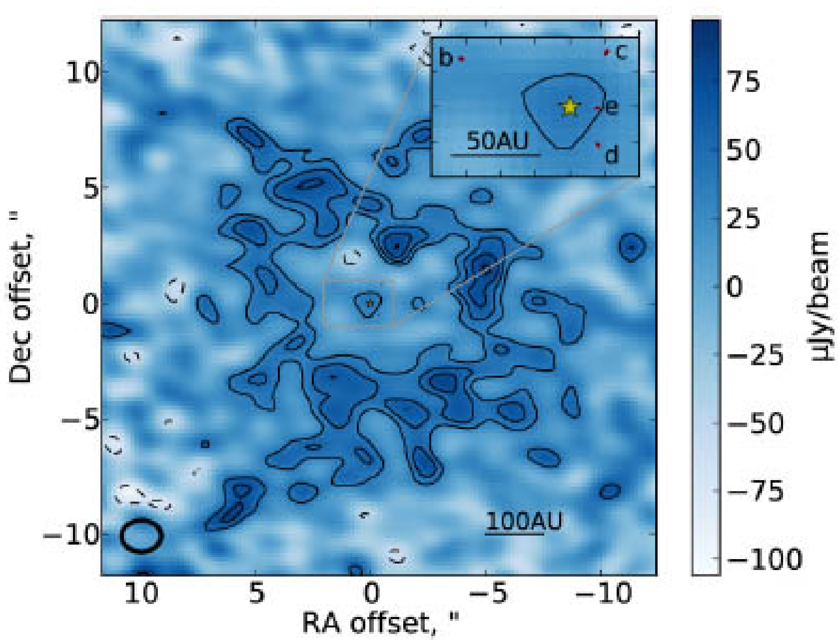
Resolving the planetesimal belt around HR8799

August 15 2016



A submillimeter image of the planetesimal disk around the star HR8799, the first directly imaged system of four exoplanets and their dust disk. The insert shows the innermost region of the system and the location of the four exoplanets. Credit: ALMA; Booth et al.

Planets develop from the dusty placental disk of material that surrounds a star after it begins to shine. The dust in that disk, according to most models, starts to stick to itself until clumps develop large enough to attract other clumps gravitationally. Astronomers believe the process of building planets and dissipating the disk takes about ten million years. Many mysteries remain, however, including the tendency of dust not to stick together, and the likelihood that colliding clumps could break apart rather than agglomerate. Recent discoveries of exoplanets have begun to overlap with studies of planetesimal disks, and enable astronomers to probe the development and evolution of a star's system of planets and their interactions with the disk.

Direct imaging of dust disks has been very limited, and so far has principally probed regions in disks at the outer zones of planetary systems – analogous to the Kuiper Belt in our own solar system. At the same time, the vast majority of exoplanets discovered and studied so far have been very close to the star, even within a distance that in the solar system would be within the orbit of Mercury. The star HR8799 is so far the only star around which direct imaging has found multiple planets. Its circumstellar disk has been known to exist for several decades, and has been modeled as having three zones: an inner asteroid belt analogue, a planetesimal belt from about one hunded astronomical units (au) to about 430 au, and a halo region extending out to over 1500 au.

CfA astronomer Denis Barkats has joined a team of colleagues to use the giant ALMA submillimeter array to image the disk around HR8799 with a spatial scale as small as only thirty-two au, enough to probe the inner zones of the disk. The team has determined that the inner edge of the planetesimal belt actually starts at around 145 au, and that the belt extends out to 430 au.

The known four exoplanets in this system orbit within this inner edge. The most distant of these four planets, planet b, has a chaotic orbit that is expected to take it beyond this inner edge, which therefore poses a stability problem in this interpretation.

The astronomers propose two interesting suggestions: either that the orbit of planet b has varied over time more than thought, or that there is a fifth, so-far undetected small planet in a larger orbit whose gravity provides some stability.

Whichever the answer, the new paper marks the dawn of a new age in imaging and analyzing extrasolar planetary systems.

More information: "Resolving the Planetesimal Belt of HR 8799 with ALMA," Mark Booth, Andres Jordan, Simon Casassus, Antonio S. Hales, William R. F. Dent, Virginie Faramaz, Luca Matra, Denis Barkats, Rafael Brahm and Jorge Cuadra, *MNRAS* 460, L10, 2016.

Provided by Harvard-Smithsonian Center for Astrophysics