The debris disc around HIP 17439 as seen by Herschel/DUNES

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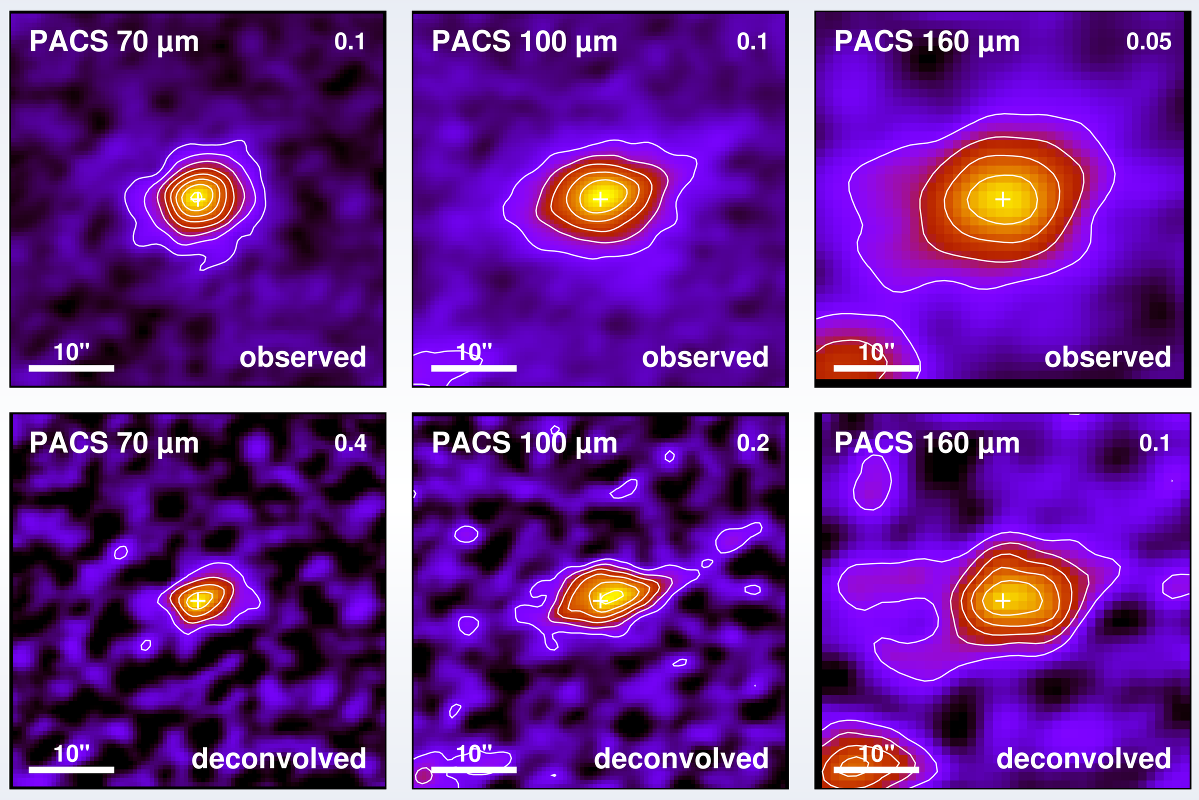
Introduction

Debris discs are a common feature around main-sequence stars and contain objects over a wide size range – from micron-sized dust grains to kilometre-sized planetesimals. The latter failed to grow to planets, and instead, slowly erode each other in a dust-producing collisional cascade. The thermal emission of the dust particles is detectable at infrared wavelengths on top of the stellar photospheric emission. The study of such an excess provides insights into the distribution of the dust as well as the transport mechanisms and collisional processes at work.

The Herschel Open-Time Key Programme DUNES (P.I.: Carlos Eiroa) aims for the detection of cold and faint debris discs down to a fractional luminosity of about 10^{-6}. The sample of 133 stars comprises Sun-like main-sequence stars within 25 pc (Eiroa et al. 2010, 2013).

One of these is HIP 17439 – a K2 V star at a distance of 16 pc from the Sun. The debris that surrounds it was first observed by IRAS and later on confirmed by Spitzer. The disc was first resolved by DUNES with Herschel's PACS and SPIRE instruments.

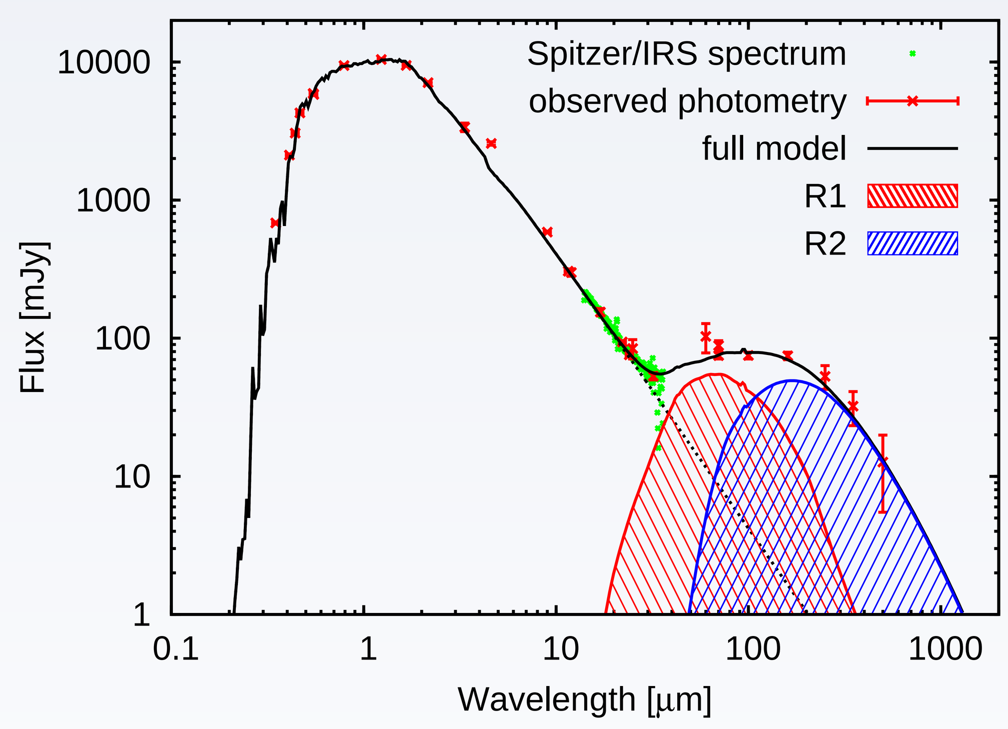
PACS Observations

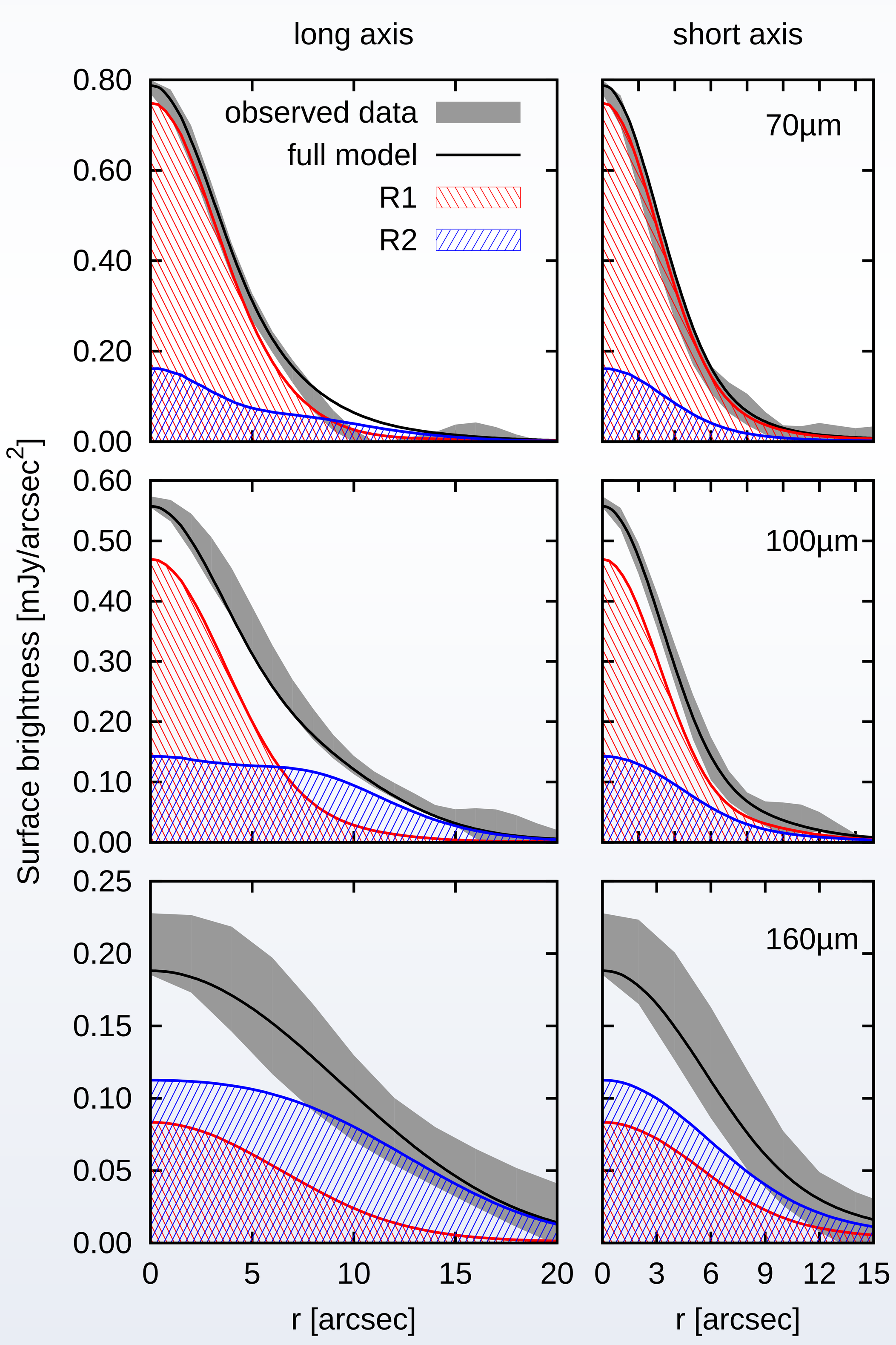


PACS original and deconvolved images show an elongated disc structure, whose size increases with the wavelength (Ertel et al., in prep.). Contour steps in mJy/arcsec^2 are indicated in the upper-right corners of the panels. At SPIRE wavelengths (250, 350, 500µm) the disc is only marginally resolved.

Modelling

Broad-ring model (SED+radial profiles)





We adopt a dust surface number density n in form of two independent power laws for size and radial distribution, i.e. $n \propto s^{-\eta} r^{-\xi}$. The dust material is assumed to be a 50 : 50 mixture of astronomical silicate and water ice. For modelling the spectral energy distribution (SED) and the radial profiles, we consider

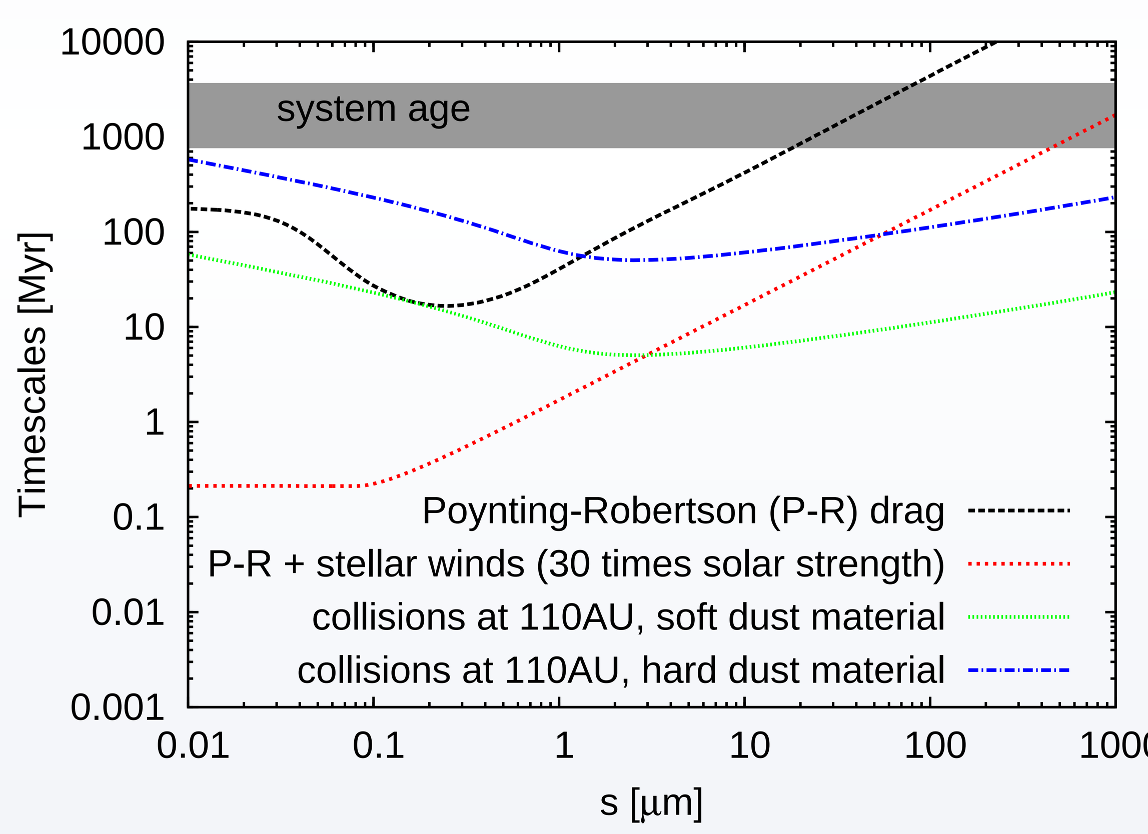
- a broad ring subdivided in two *adjacent* annuli, which we referred to as R1 and R2 or
- two *spatially separated* rings with an inner and an outer component.

Parameters:

	broad ring model		two ring model	
	R1	R2	inner comp.	outer comp.
s [µm]	1 ... 40	10 ... 1000	2. . . 1000	5. . . 1000
η	3.3	3.7	3.6	3.5
r [AU]	10. . . 110	110. . . 250	10. . . 20	90. . . 220
ξ	0.1	1	2	1.7
Inclination	71°		75°	

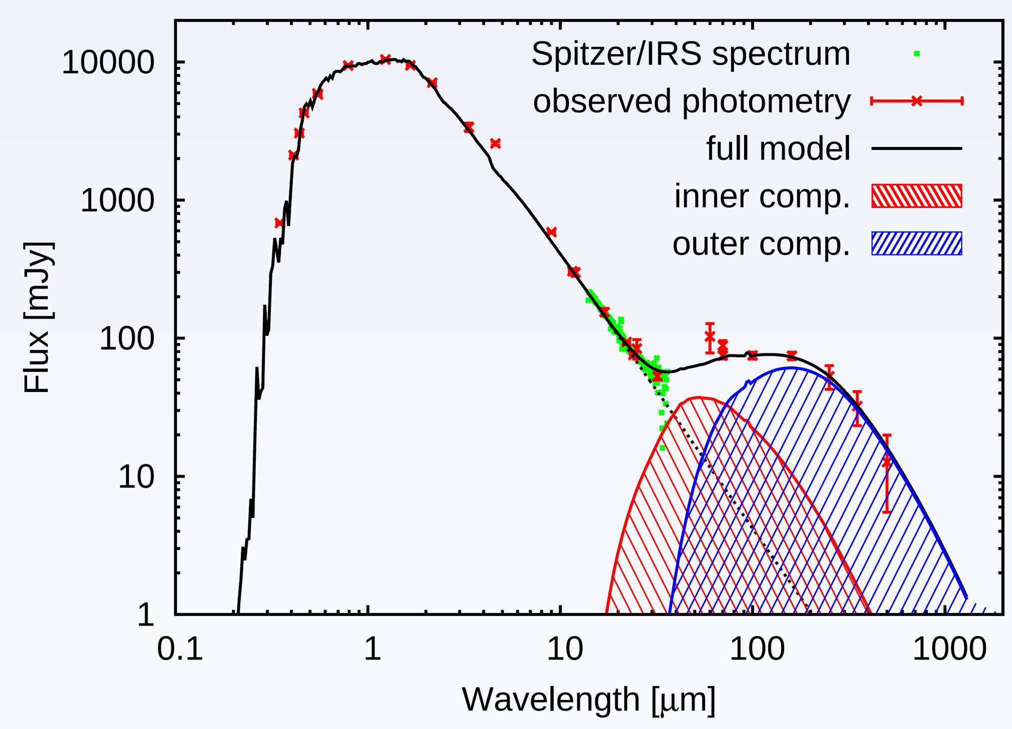
In the broad-ring model the inner part contains only particles with sizes up to 40µm. This model is consistent with inward dragged grains stemming from an outer planetesimal belt at $r > 110$AU. The inward drift is size-dependent and efficient as long as the timescale of transport is shorter than the one of collisions. On the basis of analytical timescale estimations we expect particles with few tens of µm in size in the inner region if the dust is made of hard material and, additionally, strong stellar winds are present. This model does not rule out inner planets because they trap only slower bigger particles in mean-motion resonances and prevent it from an inward movement.

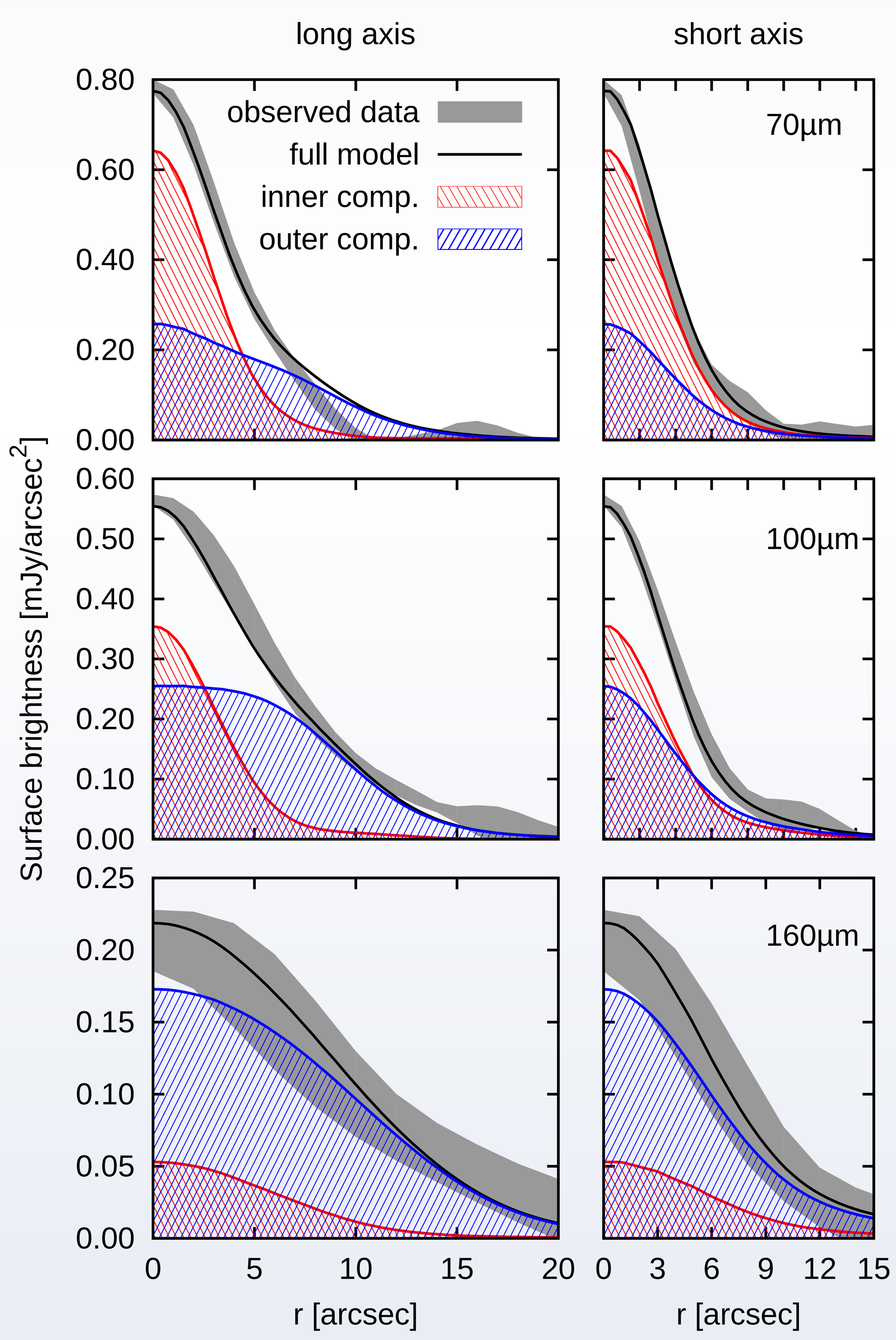
Timescales for transport and collisions



The two-component model would imply two planetesimal belts, producing an inner and an outer distribution of dust. The radial profiles are then dominated by the inner component at 70µm and by the outer at 160µm. The gap between the dust rings could suggest the presence of planets (Ertel et al., in prep.).

Two-ring model (SED+radial profiles)





Summary

The excess emission towards HIP 17439 is compatible with circumstellar dust, arranged either in a broad ring or in two separated rings.

The broad-ring scenario includes efficient material transport from an outer planetesimal belt that leads to a transport-dominated inner ring component (compare with modelling of the disc around ε Eri in Reidemeister et al. 2011). This can be well explained by the presence of stellar winds which is also supported by preliminary results with our collisional code ACE. On the other hand, observations show no evidence for strong winds, favouring the two-ring model.

In the two-component model the rings are well separated and, therefore, considered to be independent. This architecture would be a hint for the existence of planets between the rings, sweeping this region clear of planetesimals and dust.