In depth view of the debris disk around TWA7

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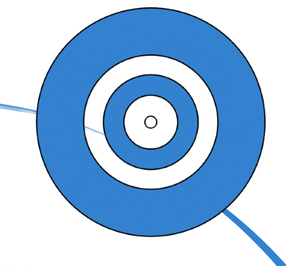
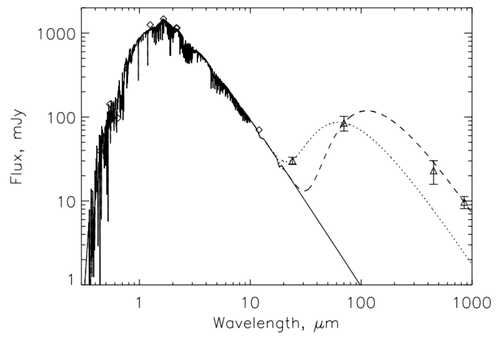
The context and the surprise!

Debris disks can be seen as the left-overs of giant planet formation and the possible nurseries of rocky planets. While M-type stars out-number more massive stars we know very little about the time evolution of their circumstellar disks at ages older than ~ 10 Myr. Sub-millimeter observations are best to provide first order estimates of the available mass reservoir and thus better constrain the evolution of such disks. Here, we present ALMA Cycle 3 Band 7 observations of the debris disk around the M2 star TWA7, which had been postulated to harbor two spatially separated dust belts, based on unresolved far-infrared and sub-millimeter data. We show that most of the emission at wavelengths longer than ~ 300 μm is in fact arising from a contaminant source, most likely a sub-mm galaxy, located at about 6.6″ East of TWA 7 (in 2016). Fortunately, the high resolution of our ALMA data allows us to disentangle the contaminant emission from that of the disc and report a significant detection of the disk in the sub-millimeter for the first time with a flux density of 2.1±0.4 mJy at 870 μm. With this detection, we show that the SED can be reproduced with a single dust belt.



TWA 7

- M2 young star ~18-38 pc away
- Belonging to TWA moving group (~8-12 Myrs)
- Slow rotator (Vsin(i) ~ 4.4 km/s)

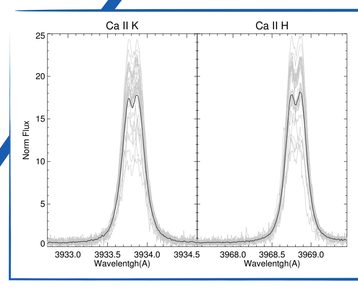


From Matthews et al. 2007, Apj, 663, 1103:

- submm observations from JCMT -> two blackbody temperatures

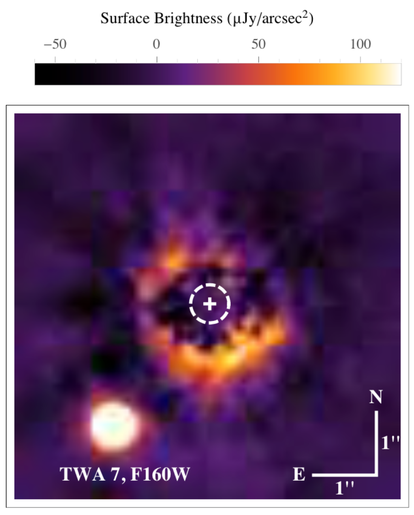
Riviere-Marichalar et al. (2007) proposes radii of 38 and 75 AU for the inner and outer belt.

Two belt face-on structure



Emission lines multi-epoch high-res. spectroscopy -> variability & double peak structure (activity & not pure pole on configuration)

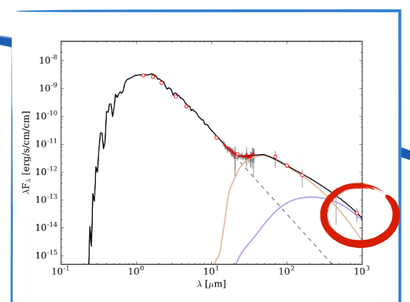
Small grains (HST data)



From Choquet et al. (2015):

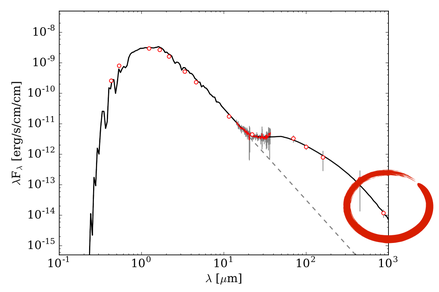
- First detection in scattered light
- Estimated belt radius ~35 or ~45 AU
- Inclination 0-44 degrees

Two belts, low inclination, inner belt at ~35 AU



SED model including constr. from Choquet et al. 2015 & JCMT data

"Large" grains (ALMA data)

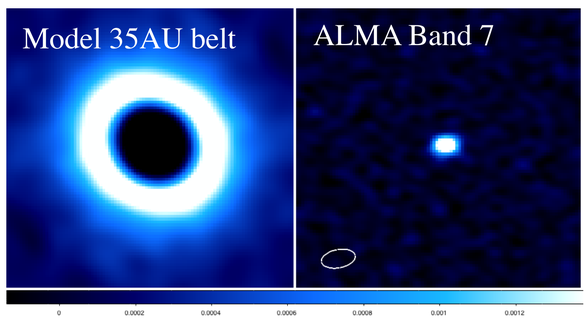


Our recent Cycle 3 ALMA data (the compact configuration SB):

- discrepant flux with respect to JCMT
- no sign of extended belt

A single belt model can reproduce the new submm SED.

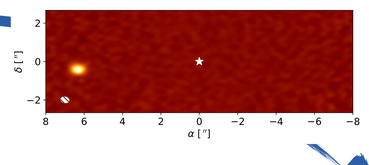
BUT: The extent of the belt imaged with HST cannot be populated by "large" grains: see below the comparison of the reconstructed ALMA image (not resolved with ~0.35" beam-size), and the expected one if the large and small grains were coupled radially (assuming constraints from Choquet et al. 2015 for the small grains)



Single compact planetesimal belt (well within 35 AU!!)

How to reconcile?

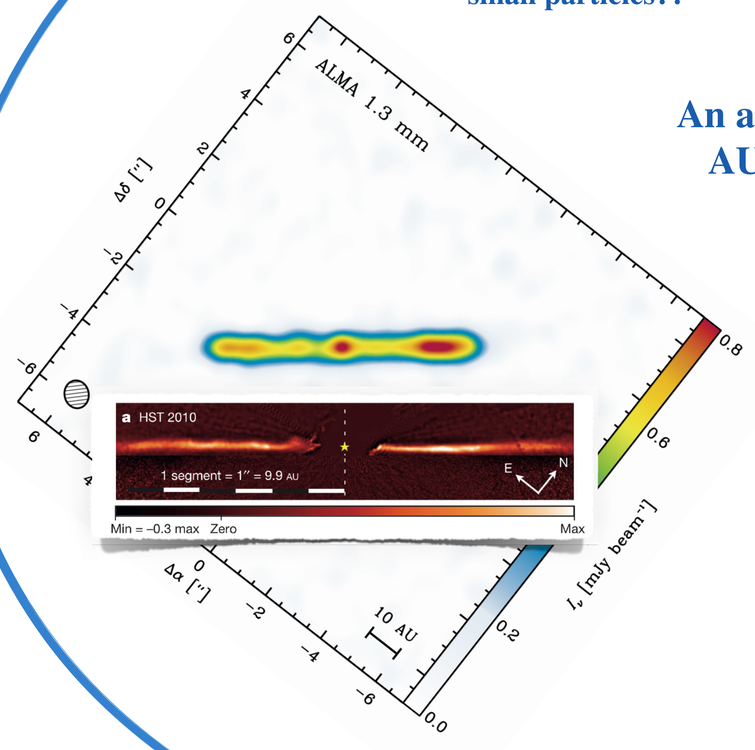
Revisit ALMA data



From the former:

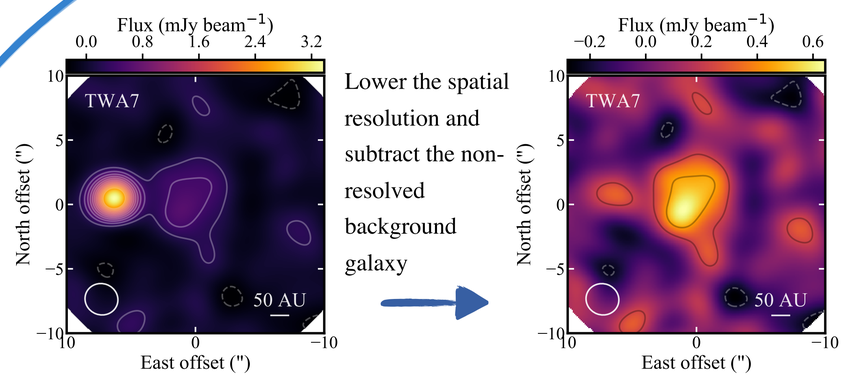
TWA 7 is surrounded by a single compact planetesimal belt (within ~7 AU!!) & further extended "halo" of small particles??

An analog to AU Mic?

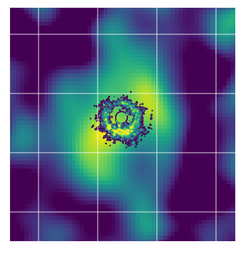


From Boccaletti et al. 2015 and MacGregor et al 2013, comparison of the extent of the disk around AU Mic in small particles (HST) and larger grains (ALMA), respectively

Previous SED was Galaxy contaminated!



Lower the spatial resolution and subtract the non-resolved background galaxy



Background ALMA, contours SPHERE IRDIS-DPI

A single ring conciliates SPHERE (Olofsson et al 2018), ALMA + decontaminated SED (Bayo et al. 2019)