The ALMA survey to resolve exoKuiper belt Substructures (ARKS): key findings and comparison with VLT/SPHERE scattered light

Context

The cold outer regions of planetary systems are among the hardest to survey for exoplanets due to the limited sensitivity of current planet detection methods. These regions are, nonetheless, rich in planetary material in the form of dusty belts analogous to the Kuiper belt, which constrain planet formation and evolution processes. ALMA has transformed our understanding of these exoKuiper belts. On one hand, dust continuum observations have constrained the morphologies of debris belts, highlighting their diversity in terms of radii, widths, and scale heights. On the other hand, CO observations indicate that exoKuiper belts often contain gas, although the origin and implications of this gas remain highly uncertain. Nevertheless, most of this progress has been made through low-angular resolution observations that have limited our ability to test existing models and theories.

Project and results

In this contribution, we propose to present the first ALMA large program dedicated to debris discs: the ALMA survey to Resolve exoKuiper belt Substructures (ARKS). We observed at high resolution 18 exoKuiper belts, which, when combined with 6 other belts with archival observations, complete a sample of 24 systems for studying the detailed structure of exo-Kuiper belts (Fig. 1). Using a mixture of parametric and non-parametric methods in the visibility and image domains, we constrained the prevalence of radial substructures, the vertical structures of belts, and the presence of asymmetries, as well as the distribution and kinematics of the CO gas in a subset of 6 systems. To interpret these results, we used a wide range of models and simulations including N-body, hydrodynamical, collisional, etc.
We also compared the spatial distribution of the dust and gas seen by ALMA with the scattered light emitted by the dust for the 15 systems which are also detected in scattered light, mostly with the VLT/SPHERE instrument (Fig. 2). For all CO-rich discs, the location of the maximum micron-sized dust surface density is significantly shifted outwards compared to the mm-sized dust surface density probed with ALMA. This confirms the impact of gas on dust migration.

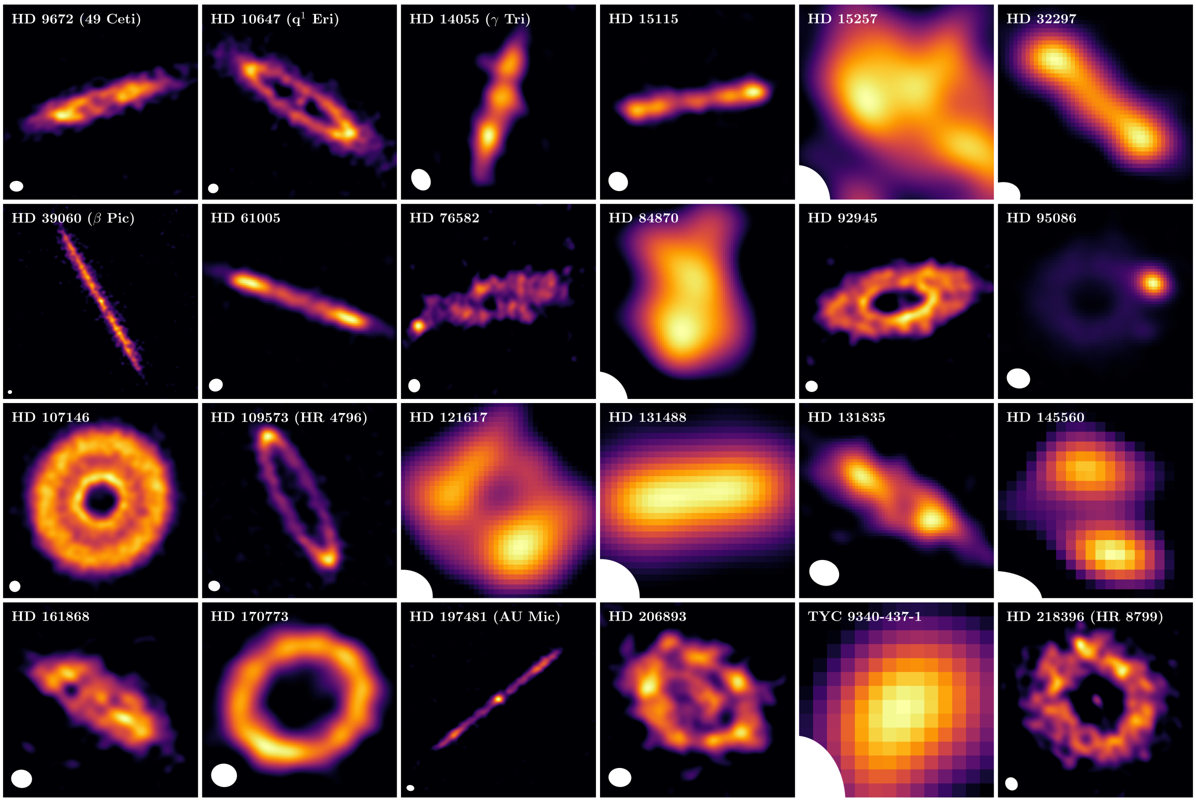

Figure 1 ALMA continuum images of the 24 systems part of ARKS

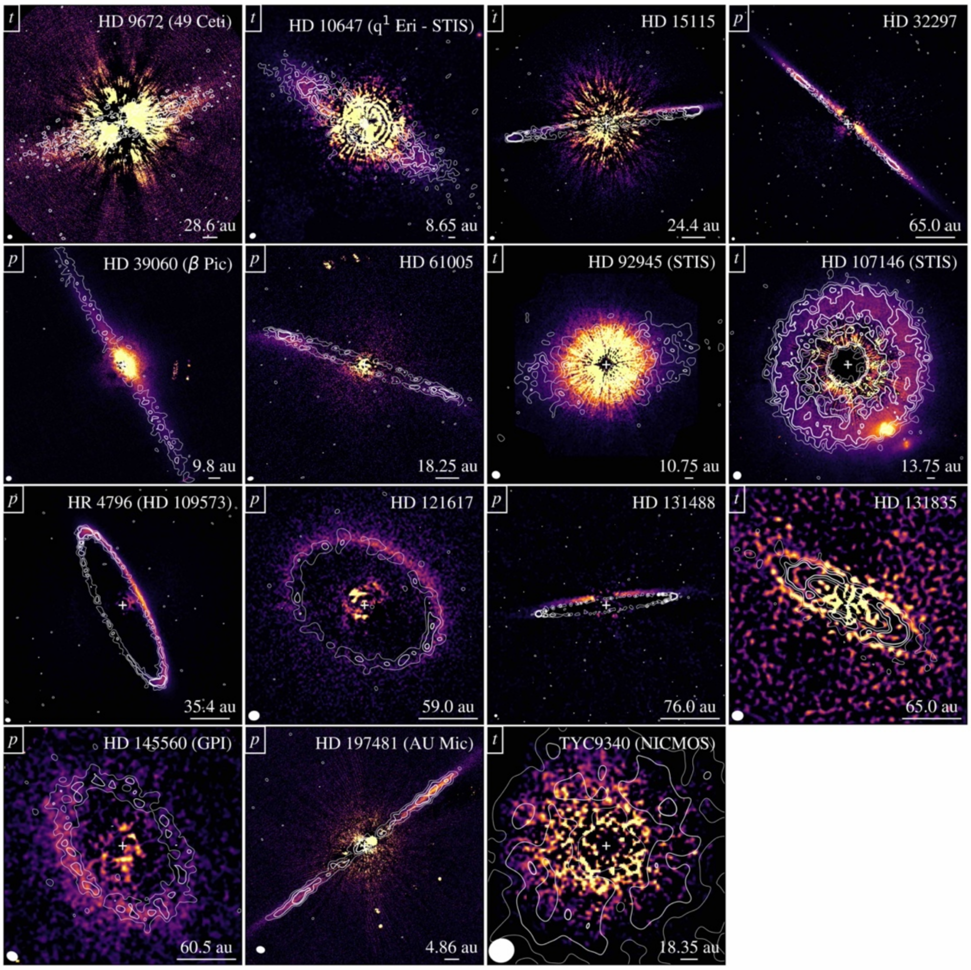

Figure 2 Near-infrared/optical images of the 15 ARKS disks detected scattered light, overlaid with the ALMA continuum contours. The observations were made using the VLT/SPHERE instrument, unless specified otherwise.