Introduction: Radial velocity and transit surveys have discovered a plethora of exoplanets at orbital distances of < 10 au around other stars [e.g., 1,2]. Planet populations and their diversity are fundamentally linked to the structure, evolution, and dispersal of protoplanetary disks at these orbital radii. The water snow line at ~1-10 au plays a key role in shaping planetary system architectures and compositions, as suggested by models and by Solar System and exoplanet data [e.g., 3,4,5]. Moreover, inner disk dispersal is proposed to increase the efficiency of rocky planetesimal formation by decreasing the gas-to-dust ratio at < 10 au through gas removal, and to directly impact the orbital architecture of planetary systems [e.g., 6,7]. Understanding disk structure and evolution is key to building a comprehensive and predictive theory of planet formation.

Access to the structure and evolution of inner regions in protoplanetary disks, at the time when planets form, is now possible. While modern imaging techniques are limited to probing disks at ≥3-4 au at best [e.g., 8,9], a suite of other observational probes of inner disks has meanwhile been steadily improving. Here we report on recent results of a large ongoing campaign aiming at revealing the physical and thermochemical evolution of planet-forming disk regions, at ~0.05-20 au in protoplanetary disks.

A high-resolution, multi-tracer campaign: The first and main component of this campaign is high-resolution spectroscopy of molecular gas emission as observed at infrared wavelengths from protoplanetary disks. Infrared spectra of the main molecular tracers (CO, H₂O, OH, and some organic molecules) are rich in transitions that probe temperatures and densities found in planet-forming regions [10,11]. Their line profiles, broadened by Keplerian rotation around the central star, can be observed in full detail by high-resolution spectrographs on large telescopes with resolving powers of R~100,000 [12,13]. Detailed line shapes and fluxes, in turn, provide spatially-resolved information on temperatures, density, excitation, and dispersal of molecular gas in inner disks, including regions that are unreachable by direct imaging.

In addition to using high-resolution infrared spectroscopy to obtain spatially-resolved measurements in inner disks, the key elements of this campaign are: 1) the collection of an increasingly larger sample of protoplanetary disks (>50 young disks around stars of masses between 0.3 and 3.5 solar masses), 2) the combined analysis of observed spectra of multiple molecules (first of all CO and H₂O, see Figure 1(a)), 3) the combination of multiple tracers, including molecular gas, dust, and atomic gas emission to probe both the gas and the dust, and both the disks and the winds that disperse them. By combining multiple datasets from a suite of telescopes from the ground and in space, we are working our way towards obtaining a global view of the evolution of planet-forming disk regions.

Disk cavities, and inner disk depletion: The analysis of high-resolution line profiles of rovibration- al CO emission at 4.7 micron provided a groundbreaking discovery, and a fundamental framework for other datasets. CO lines excited in inner disks are observed to have line widths in the range of ~10-200 km/s, which correspond to Keplerian orbits of ~0.05-20 au (where larger velocity widths imply smaller orbits for the gas, and vice versa). A correlation has been discovered between the orbital radius of CO emission as derived from line widths (R_CO), and the ratio of line fluxes between the second and first vibrational states, a sensitive “thermometer” of temperature and irradiation. Figures 1(b) and (c) show the sequence of inner disk depletion that this correlation has revealed: as CO emission moves to larger orbital radii (a consequence of removal of CO at smaller orbital radii), the observed emission probes colder and colder disk regions [14].

The dry-out of planet-forming disk regions: As a second step, we have combined the analysis of rovibration-al CO emission and of H₂O vapor emission observed from inner disks [15]. The large sample of >50 disks, coupled to the large coverage of water energy levels (~1000-9000 K), and to the orbital constraints provided by CO lines, clarified early findings of water-rich and water-poor disks in spectrally-unresolved observations [16]. Protoplanetary disks that show water-
vapor-rich infrared spectra are found to have broad CO emission lines, demonstrating that their inner orbital regions are still rich in molecular gas. On the contrary, water emission fades away as CO lines become narrower, i.e. as the size of the inner disk cavity expands to larger disk radii. Water vapor emission disappears when the inner cavity reaches and exceeds the water snow line radius [15, Figure 1], beyond which water is frozen on icy bodies that, by migration and accretion, deliver water to the inner disk dry bodies [e.g. 17].

**Dust and gas evolution, and dispersing winds:**
The next steps of this campaign include the combined analysis of molecular spectra and of tracers of inner disk dust and winds. In a series of papers in preparation, we are now exploring 1) the linked depletion of gas and dust in inner disks, pointing at the role of dust accretion into planetesimals and planets [18,19], and 2) the presence, nature, and effects of winds that disperse inner disks [6,20], which may contribute to the formation of the cavities observed in dust and in molecular gas. All together, these observations are providing and essential guidance towards a global understanding of the evolution of planet-forming regions, and of their links to the architecture and composition of planetary systems.

**References:**