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The Structure and Composition of Protoplanetary Disks

DAN WATSON, Department of Physics and Astronomy, University of Rochester

The Spitzer Space Telescope observed all but a few percent of the 2500 protoplanetary disks within 500 parsecs of the Solar System, at the infrared wavelengths at which these objects produce most of their luminosity. The sample covers completely the mass range of hydrogen-burning stars, and penetrates well into the domain of brown dwarfs, as young as several hundred thousand years. It includes disks subjected to an extremely large range of environmental conditions, from the high-density, high-UV regions of massive star formation like the Orion A cloud, to the quiet expanses of exclusively low-mass star formation in the Taurus-Auriga cloud. Here we will offer a brief review of these results, with an eye to noting new constraints which the observations can place on the gas and plasma dynamics of the objects. In particular, the observations include demonstrations of dust settling and gap formation in protoplanetary disks, of grain growth and mineralization of the dust, and of the presence of prebiotic molecules, all on scales similar to the range of planetary orbits in our own Solar system. The results bear on the physics of formation of terrestrial and giant planets, and on radial transport of gas and dust in both the partially-ionized upper layers and in the neutral “dead zone” beneath.