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Tangled infall signatures in the L1448N region in the Perseus molecular cloud

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The formation of stars has been subject to extensive studies in the past decades from molecular cloud to protoplanetary disk scales. It is still not fully understood how the surrounding material in a protostellar system, that often shows asymmetric structures with complex kinematic properties, is delivered onto the disk and how this may shape the properties of the protostar and disk. We present 1 mm NOEMA observations of the PRODIGE large program and analyze the kinematic properties of molecular lines in the L1448N region located in the Perseus molecular cloud tracing scales from 6000 au down to the disk scales at 300 au. This data set is complemented by sensitive IRAM 30m maps of the ANTIHEROES large program expanding the spatial scales up to several 10000s au. This region harbors three Class 0/I protostellar sytems with distinct properties. IRS3A is a single protostar and has a ring-like disk, IRS3B is one of the largest known disks with spiral arms harbouring a triple system, and within the binary IRS3C each of the protostars have a compact disk. The high spectral resolution data of molecular lines reveal extended molecular gas with complex kinematic properties. The clustering algorithm DBSCAN is used to disentangle velocity components into the underlying physical structure. We discover an extended gas bridge (≈3000 au) surrounding both the IRS3A and IRS3B systems. The velocity gradients along the gas bridge are on the order of 100 km/s/pc and point towards the IRS3A system. We find that the observed velocity profile is consistent with analytical streamline models of gravitational infall towards IRS3A. Towards IRS3C we find multiple infalling structures detected each in distinct molecular tracers that may feed each of the disks within the binary. The PRODIGE and ANTIHEROES molecular gas observations reveal that these systems are still embedded within a common large-scale mass reservoir with a complex spatial morphology as well as velocity profiles tracing not only disk/envelope rotation and outflows, but also large-scale infall.

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