BISTRO explores complex magnetic field structure of Cat's Paw Nebula

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Infrared image of the Cat's Paw Nebula obtained with NASA's Spitzer telescope. Credit: NASA/JPL-Caltech

An international team of astronomers has investigated a nearby emission nebula and star-forming region dubbed the Cat's Paw Nebula as part of the B-field In STar-forming Region Observations (BISTRO) survey. Results of this study, presented in a paper published December 24 on arXiv.org, provide essential information about the structure of the object's complex magnetic field.

At a distance of some 4,240 light years away, the Cat's Paw Nebula (other designations: NGC 6334, Gum 64) is a high-mass star-forming

complex that lies within the galactic plane. The nebula has a form of a filamentary cloud structure spanning 1,000 light years and hosts several star-forming regions.

Observations show that NGC 6334 is dominated by both a dense ridge threaded by sub-filaments, and by two hub-like structures towards its Northeast end. Astronomers have found that this ridge itself is in the process of active high-mass star formation and ultra-compact HII regions, maser sources, and molecular outflows have been identified along or next to its crest. However, although column density and velocity structures of the nebula's both filaments and hubs have been thoroughly studied, still very little is known about its magnetic field (B-field).

In order to advance our knowledge in this matter, a group of astronomers led by Doris Arzoumanian of the University of Porto, Portugal, analyzed observations of the dust polarized emission at 850μm obtained with the SCUBA-2/POL-2 instrument of the James Clerk Maxwell Telescope (JCMT).

"To gain insight into the B-field structure along dense filaments and improve our understanding of the role of the magnetic field in the star formation process, we analyze new 850μm data obtained towards the NGC 6334 star-forming filamentary region observed as part of the B-field In STar-forming Region Observations (BISTRO) using SCUBA-2/POL-2 installed on the James Clerk Maxwell Telescope (JCMT)," the researchers wrote in the paper.

According to the study, NGC 6334 showcases a complex B-field structure when observed over the whole region (around 33 light years), however, at smaller scales the plane-of-the-sky (POS) B-field angle varies coherently along the crests of the filament network.

The astronomers investigated the variation of the polarization and

physical properties along the sub-filaments from their outer to their inner parts. They found that in the outer parts, the POS magnetic field shows mostly perpendicular or random orientation with respect to the sub-filament crests, while in the inner parts, the B-field is parallel to their crests. The researchers assume that such change of relative orientation along the sub-filaments may be due to material flowing along their crests onto the ridge and hubs.

"This variation of the B-field structure along the sub-filaments may be tracing local velocity flows of matter in-falling onto the ridge and hubs," the paper reads.

Furthermore, the results point out to a variation of the energy balance along the crests of these sub-filaments, from magnetically critical/supercritical at their far ends to magnetically subcritical near the ridge and hubs. An increase of polarized fraction toward the high-column density star cluster-forming hubs was also detected by the study.

The researchers propose further monitoring of NGC 6334, mostly higher angular resolution observations, which could be crucial to better understand the role of the magnetic field in the matter assembly and fragmentation processes that lead to the formation of massive stars.

More information: Dust polarized emission observations of NGC 6334, arXiv:2012.13060 [astro-ph.GA] arxiv.org/abs/2012.13060