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PRESS RELEASES

Molecular Hydrogen Formation Makes Dust Spin

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Columbia, Md., Sept. 25, 2013 - *USRA-led team finds polarized starlight implicates interstellar dust as host of hydrogen molecule formation, allows tracing magnetic fields in space.*

In a paper published in the Oct. 1, 2013, issue of The Astrophysical Journal, an integrated team of observers and theoreticians led by USRA astronomer Dr. B-G Andersson, has used telescopes in Spain, Hawaii, Arizona, and New Mexico, to show - for the first time - that intense molecular hydrogen (H2) formation leads to an increase in the amount of polarization seen when starlight passes through dust clouds in the interstellar medium.

"While interstellar polarization has been known since 1949, the physical mechanisms behind grain alignment have been poorly understood until recently," said Dr. Andersson. "These observations form part of a coordinated effort to - after more than 60 years - place interstellar grain alignment on a solid theoretical and observational footing."

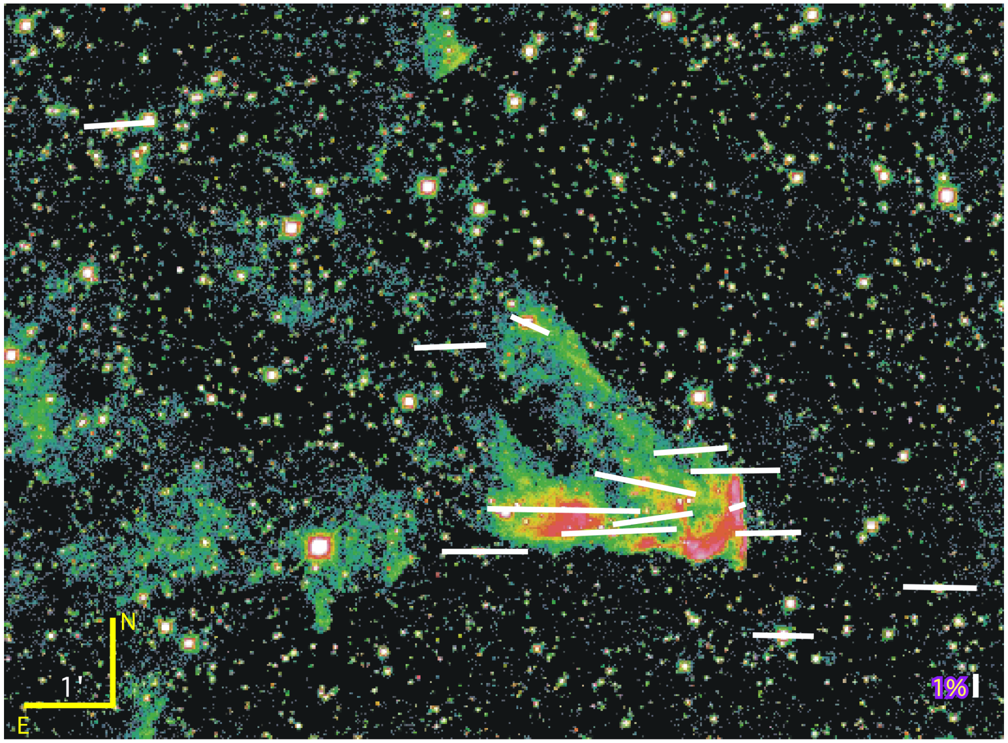

Image: Intense molecular hydrogen formation gives rise to near infrared emission in the reflection nebula IC 63, in Cassiopeia (false color image). The white bars represent the polarization seen towards stars background to the nebula (the length of the bars shows the amount of polarization and their orientation the position angle of the polarization). The largest polarization coincides with the most intense emission, showing that H2 formation on the grain surfaces contribute to the alignment of the dust grains with the magnetic field. (B-G Andersson, et. al)

Collaborating with the University of Wisconsinâ€"Madison's Professor Alexandre Lazarian, developer of the Radiative Alignment Torque (RAT) theory for grain alignment, and researchers from as far away as Hawaii and Finland, Andersson and Lazarian's team used optical and near infrared polarimetry, high-accuracy optical spectroscopy and photometry, and sensitive imaging of a near infrared emission line of H2 for their studies.

Interstellar magnetic fields are thought to be critically important in regulating star formation and the evolution of proto-planetary disks. Magnetic fields are, however, difficult to probe quantitatively in the interstellar medium.

From this research, the authors sought to demonstrate an observationally validated, quantitative theory of interstellar grain alignment allowing the polarization observed in visual and infrared light to be used to reliably probe the structure and strength of the magnetic field.

By comparing their data to the predictions of RAT theory, the team was able to show that their observations agree with detailed theoretical models and to derive further specific predictions, which can be tested with additional observations.

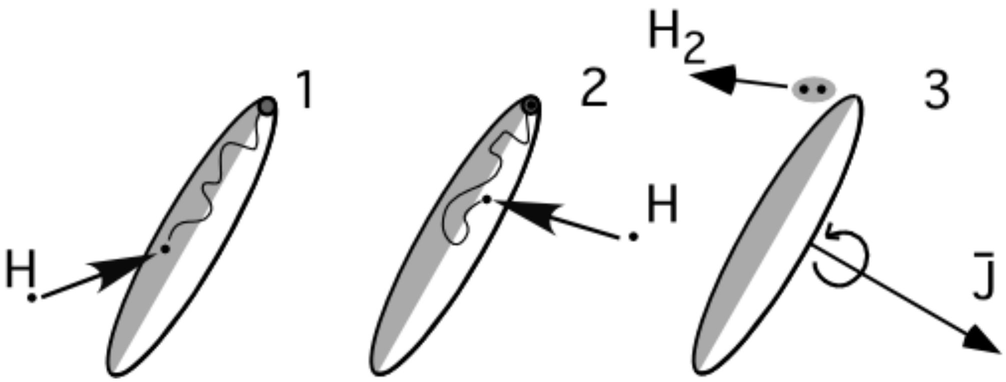

Image: In the interstellar medium, molecular hydrogen is formed when two hydrogen atoms stick to the surface of a dust grain and after migrating to an "active site" combine. The reaction force on the dust grain, as a newly formed H2 molecule is ejected from it, will cause the grain to spin rapidly, which in combination with the alignment processes due to "Radiative Alignment Torques," will align the grain with the magnetic field. (B-G Andersson, et. al)

Evolving Grain Alignment Theory

The H2 molecule, the most common molecule in the universe, cannot form in the gas phase since the two atoms cannot get rid of the formation energy without a third body. Therefore, in 1948, Dutch astronomer Henrik van der Hulst proposed that H2 is formed on the surfaces of dust grains in the interstellar medium.

The fact that a connection is seen between H2 formation and grain alignment helps confirm that the formation of the molecule takes place on the surfaces of dust grains.

In 1979, Nobel laureate Edwin Purcell predicted that if the formation sites on the grain surface stayed localized over time, the reaction force of the ejection would result in a net torque that would spin the grains up to high rotations speeds - as if little rocket motors were attached to the formation sites - so called "Purcell Rockets."

Spinning grains are expected to interact with the magnetic field that the dust grain is embedded in and become aligned with their spin axes along the magnetic field direction. If the grains are asymmetric (e.g. oblate spheroids or "discus shaped") this will mean that the material will act as a polarizing screen, which can be probed by observing stars that shine through the interstellar cloud, made of gas and dust.

To advance the work on resolving the mystery of grain alignment theory, Andersson and Lazarian's team received strong support from the National Science Foundation to bring together both observational and theoretical research efforts. The team's findings are discussed in greater detail in the article "Evidence for H2 Formation Driven Dust Grain Alignment in IC 63" in The Astrophysical Journal (Volume 775, Number 2, Oct. 1, 2013), at: www. http://iopscience.iop.org.

Lead author B-G Andersson serves as the science operations manager at the USRA-managed Stratospheric Observatory for Infrared Astronomy (SOFIA) Science Center at the NASA Ames Research Center at Moffett Field, Calif. SOFIA is NASA's newest airborne observatory consisting of a 2.5-meter diameter infrared telescope fitted into a highly modified Boeing 747SP jetliner.

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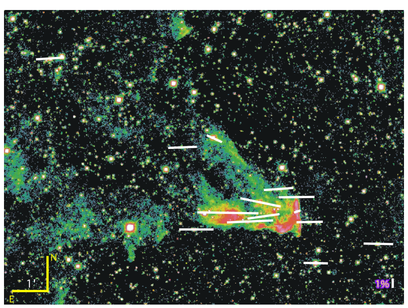

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