

**OUR SOLAR SYSTEM AND HELIOSPHERE IN THE VERY LOCAL INTERSTELLAR MEDIUM: EXPLORATION BY NEW HORIZONS, VOYAGER, IBEX, IMAP AND A FUTURE INTERSTELLAR PROBE.** P. C. Brandt<sup>1</sup>, S. A. Stern<sup>2</sup>, L. Spilker<sup>3</sup>, H. Elliott<sup>4</sup>, J. Richardson<sup>5</sup>, M. E. Hill<sup>1</sup>, P. Kollmann<sup>1</sup>, R. L. McNutt<sup>1</sup>, P. Mostafavi<sup>1</sup>, D. J. McComas<sup>6</sup>, R. Gladstone<sup>4</sup>, M. Horanyi<sup>7</sup>, A. Poppe<sup>8</sup>, E. Provornikova<sup>1</sup>, M. Opher<sup>9</sup>, J. Linsky<sup>10</sup>, S. Redfield<sup>11</sup>, T. Lauer<sup>12</sup>, K. Singer<sup>2</sup>, J. Spencer<sup>2</sup>, A. Verbiscer<sup>2</sup>, <sup>1</sup>The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA (pontus.brandt@jhuapl.edu), <sup>2</sup>Southwest Research Institute, Boulder, CO, , <sup>3</sup>Jet Propulsion Laboratory, Pasadena, CA, <sup>4</sup>Southwest Research Institute, San Antonio, TX, <sup>5</sup>Massachusetts Institute of Technology, Cambridge, MA, <sup>6</sup>Princeton University, Princeton, NJ, <sup>7</sup>Laboratory for Atmospheric and Space Physics, Boulder, CO, <sup>8</sup>Space Science Laboratory, Berkeley, CA, <sup>9</sup>Boston University, Boston, MA, <sup>10</sup>University of Colorado, Boulder, CO, <sup>11</sup>Weslayan University, Middletown, CT, <sup>12</sup>National Optical-Infrared Astronomy Research Laboratory, Tucson, AZ.

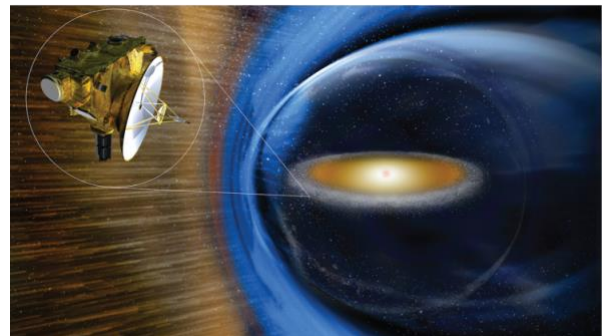
Our solar system has evolved through accretion of dust and gas as the Sun and its protective magnetic bubble – “the heliosphere” - have plowed through interstellar space on its journey through the galaxy. Over the course of its evolution, the solar system has encountered dramatically different interstellar properties resulting in a severely compressed heliosphere with periods of full exposures of interstellar gas, plasma, dust and galactic cosmic rays (GCRs) that all have helped shaped the system we live in today. Our current knowledge lacks the direct measurements necessary to understand how our star upholds its vast heliosphere and its potentially game-changing role in the evolution of our galactic home.

Voyager 1 and 2 are now in the Very Local Interstellar Medium (VLISM), where they are expected to operate until the mid-2030’s having uncovered many unexpected discoveries and mysteries. After its paradigm-shifting discoveries at Pluto and Arrokoth, New Horizons is currently the only spacecraft exploring the Kuiper Belt. It continues to break new ground in understanding the formation of our solar system by revealing the properties of multiple distant Kuiper Belt Objects and provide critical constraints on the structure of the Sun’s enormous dust disk. Because of its distant position, New Horizons is also providing the unprecedented estimates of the cosmic background.

New Horizons is projected to operate well into the 2040’s, across the heliospheric the heliospheric boundaries with new measurements that will shed light on many of the mysteries of our heliosphere. Now passing 55 au, New Horizons is uniquely positioned to investigate the evolution of the solar wind, energetic particles, GCRs, and, in particular interstellar Pick-Up Ions (PUIs) that Voyager was not equipped to measure, to help constrain the structure and dynamics of the heliosphere. Observations of GCRs offers an opportunity to understand how these scatter strongly in the wavy structure of the “ballerina skirt” of the solar magnetic field leading to the strong modulation as part of the overall heliospheric shielding.

As New Horizons continues to travel outward, dust measurements may reveal an interstellar component that will provide the strongest constraint to date on how interstellar dust grains interact with the heliosphere. Now beyond the infrared and UV haze of the circumsolar dust and hydrogen gas, the Alice UV camera holds promise to search for signatures of the hydrogen wall and perhaps even signatures of our neighboring interstellar clouds.

In this presentation we provide an overview of New Horizons’ observations in the context of the exploration by Voyager, IBEX, and IMAP. We conclude by providing a status of the future Interstellar Probe mission concept that is now under consideration in the Solar and Space Physics Decadal Survey.



**Figure 1:** New Horizons is now passing 55 au, where it continues to uncover the properties of distant KBOs, Ice Giants, dust and provide important estimates of the cosmic background. It is also the only spacecraft in the outer heliosphere providing new measurements that help understand the heliosphere and its interaction with the VLISM.