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This presentation provides an overview of opportunities in turbulence research that are made available due to the unique character of the PUNCH dataset. (i) Anisotropy of correlations is a well-established in homogeneous MHD and in local solar wind observations of turbulence [1]. Correlation anisotropy may be revealed in images, as demonstrated in [2] by computing local structure functions (see Yang et al, this meeting). PUNCH broadens the scope by providing a huge field of view that may be partitioned into small segments. (ii) At scales greater than a few correlation lengths, in situ signals are associated with observed “1/f” flicker noise seen in the interplanetary magnetic field [3]. The associated spatial structures are present in the PUNCH images. The search for this correspondence may proceed in several ways: (iii) So-called “k-omega” analysis is used in the PUNCH project as a type of flow tracking. Closely related to this technique is the computation of the space-time correlation function, a fundamental turbulence quantity [4,5]. Analysis of PUNCH images will provide space time correlation at scales and at positions never before accessible. (iv). It has already been established that heliospheric imaging can track cometary ejecta (bright spots on the images) based on analysis of Comet Enke [6]. The statistics of the velocity and position of the bright points can be analyzed in terms of Langevin with drag and random forcing. PUNCH is expected to observed the passage of numerous comets, thus enabling a much deeper dive into interplanetary turbulence from this unique perspective.

[1] Oughton S, Matthaeus WH, Wan M, Osman KT. 2015. Phil. Trans. R. Soc. A 373: 20140152.
[2] DeForest, C. E, W. H. Matthaeus, N. M. Viall, and S. R. Cranmer, Astrophys J., 828, 676 (2016)
[3] Wang, J., W. H. Matthaeus, R. Chhiber, S. Roy, R. A. Pradata, F. Pecora & Y. Yang. Solar Phys 299:169 (2024)
[4] Matthaeus, W. H, J. M. Weygand, and S. Dasso, Phys Rev. Letter, 116, 245101 (2016)
[5] Pecora F, W. H. Matthaeus, A. Greco, P. Dmirtuk, Y. Yang. V. Carbone & S. Servidio, PNAS 122 (2025)
[6] DeForest, C. E., W. H. Matthaeus. T. A. Howard and R. R. Rice. Astrophys. J. 812, 108 (2015)
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