

Characterization of the Optical and X-ray Properties of the Northwestern Wisps in the Crab Nebula

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We have studied the variability of the Crab Nebula both in the visible and in X-rays. Optical observations were obtained using the Nordic Optical Telescope in La Palma and X-ray observations were made with the Chandra X-Ray Observatory. We observe wisps forming and peeling off from the region commonly associated with the termination shock of the pulsar wind. We measure a number of properties of the wisps to the Northwest of the pulsar. We find that the exact locations of the wisps in the optical and in X-rays are similar but not coincident, with the X-ray wisp preferentially located closer to the pulsar. Our measurements and their implications are interpreted in terms of a MHD model. We find that the optical wisps are more strongly Doppler boosted than X-ray wisps, a result inconsistent with current MHD simulations. Indeed the inferred optical boosting factors exceed MHD simulation values by about one order of magnitude. These findings suggest that the optical and X-ray wisps are not produced by the same particle distribution, a result which is consistent with the spatial differences. Further, the X-ray wisps and optical wisps are apparently developing independently from each other, but every time a new X-ray wisp is born so is an optical wisp, thus pointing to a possible common cause or trigger. Finally, we find that the typical wisp formation rate is approximately once per year, interestingly at about the same rate of production of the large gamma-ray flares.

High Energy Astrophysics Division 2013 Meeting
Monterey, California
April 7-11 2013