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Observations of interstellar Ne at 1 AU

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Interstellar pickup ions are produced by ionization of interstellar neutral atoms which can penetrate the heliosphere unimpeded through the heliopause. The relative motion of the interstellar medium in respect to the heliosphere causes them to drift towards the sun with v=26km/s where they are gradually ionized by solar radiation and charge exchange with solar protons. Once ionized, the new born ions are "picked up" by the solar wind magnetic field and carried outwards. Accordingly interstellar neutrals of high First Ionization Potentials (FIP) or rather low ionization probability, e.g. helium and neon, are not significantly depleted in the vicinity of the sun and can be observed by spacecraft like STEREO A and B. Signatures of other pickup ions, e.g. carbon, nitrogen, and oxygen must be due to an inner source because corresponding interstellar neutrals are ionized much further away from the sun. Processes which could lead to an inner source of pickup ions are not fully understood but are possibly connected to re-ionization of neutralized solar wind ions that are trapped in small dust particles orbiting the sun.

Associated with the different source regions of interstellar and inner-source PUIs is the formation of the so-called focusing cone. Due to solar gravitation interstellar atoms are focused behind the sun in respect to the direction from which they arrived. This focusing effect can be (and has been) observed for He+ in form of an enhanced pickup He+ flux once a year for an earth-bound spacecraft and every 346 and 388 days for STEREO A and B respectively. On the contrary focusing of inner-source pickup ions is not observed nor expected due to their lower FIP.

STEREO PLASTIC's big geometric factor and the current unusual prolonged solar minimum allows for the first time investigation of these rare pickup ions with unprecedented quality. Within the framework of our analysis we were able to identify signatures of inner-source carbon, nitrogen, and oxygen as well as interstellar helium and neon using STEREO PLASTIC's Pulse Height Analysis data. We have investigated long time series of pickup count rates between 2007 and 2009 of He^+, C^+, and O^+ which show a significant formation of the focusing cone for the interstellar component of pickup ions. In agreement with theoretical expectations focusing of inner-source PUIs, i.e. C^+ and O^+, is not observed. By comparing mass-per-charge spectra inside and outside the cone, we have succeeded in distinguishing interstellar from inner-source Ne^+ pickup ions. This constitutes the first discovery of interstellar Ne at 1 AU.