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Proton beam velocity distributions and prominence material in ICME

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Abstract

This work discusses two phenomena in Interplanetary Coronal Mass Ejection (ICME)(1)proton beam velocity distribution (2) cold high-density material. The plasma and magnetic-field instruments on the Helios 2 spacecraft detected three events of interplanetary coronal mass ejections, which occurred on 3 April 1979 at the location of 0.68 AU, on 9 May 1979 at 0.29 AU and on 30 March 1976 at 0.48 AU, named as case 1, case 2 and case 3, respectively. All three cases were revealed by the typical signature of magnetic field rotation, indicating a force-free magnetic flux tube. We present here, to our knowledge for the first time, the detailed proton velocity distributions measured within an ICME. In case 1, a beam velocity distribution was observed which lasted for almost an hour. These cold distributions were characterized by an isotropic core part with a low temperature, $T \leq 10^5$ K, and by a broad and extended hot proton beam propagating along the local magnetic field direction with a speed of a sizable fraction of the local Alfvén speed. The beams appeared to be unusual as compared with the ambient ICME protons which were comparatively isotropic. In case 2 and 3, the ICME contained a trailing part with high proton density and lower proton temperature. This phenomenon lasted for almost 2 hours for each case and may indicate the existence of prominence material.The corresponding velocity distribution showed a trend to form a beam which is different from the ambient ICME. These beam velocity distributions may indicate a property of the source region of the prominence material on the sun.