# Determining the kappa index of space plasma distributions from observations in a limited energy range

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The fluid parameters of space plasmas can be derived from the distribution function of the plasma in the velocity space, which can be constructed from observations. Two common methods to derive the plasma parameters from the distribution function i) by calculating the distributions moments via integration and b) by fitting the distribution with an analytical function of the plasma parameters. When the first method is used, the full 3-dimensional distribution function of the ions species should be constructed from the observations in order to be integrated. For the second method, a specific analytical expression of the distribution function should be determined in order to explore for which parameters the expression fits the observations. Space plasmas are often described by kappa distributions. The core of such distributions is a Maxwell-like distribution while the high energy tails are power law- like distributions. The kappa index of the distribution should be defined for the accurate description of the plasma and its fluid parameters. For example, previous studies have shown that the plasma temperature can be significantly misestimated if the Maxwell distribution is used to describe plasmas that follow the kappa distribution. Typically, the kappa index is determined by fitting the high energy tails of the distribution, thus it gets very difficult or not possible to do so, when the high energy tails are not clearly observed. This can be illustrated with the observations of solar wind using an electrostatic analyzer (measures energy per charge); the proton distribution peaks at ≈1keV/q but the high energy tail is covered by the alpha particle distribution which peaks at ≈2keV/q. We demonstrate how the kappa index of plasma distributions can be still determined from observations at limited energy range, near the distributions maximum value. The approach reduces the free parameters when we perform complicated fittings of 3-D distribution functions. We first explain the mathematical formulas used for our approach and then demonstrate the techniques with pseudo-observations of plasma particles.

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