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A General Identification of Instabilities in Solar Wind Plasma, and a Particular Application to the WIND Data Set.

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The role of free-energy driven instabilities in governing heating and acceleration processes in the heliosphere has been studied for over half a century, with significant recent advancements enabled by the statistical analysis of decades worth of observations from missions such as WIND. Typical studies focus on marginal stability boundaries in a reduced parameter space, such as the canonical plasma beta versus temperature anisotropy plane, due to a single source of free energy. We present a more general method of determining stability, accounting for all possible sources of free energy in the constituent plasma velocity distributions. Through this novel implementation, we can efficiently determine if the plasma is linearly unstable, and if so, how many normal modes are growing. Such identification will enabling us to better pinpoint the dominant heating or acceleration processes in solar wind plasma. The theory behind this approach is reviewed, followed by a discussion of our methods for a robust numerical implementation, and an initial application to portions of the WIND data set. Further application of this method to velocity distribution measurements from current missions, including WIND, upcoming missions, including Solar Probe Plus and Solar Orbiter, and missions currently in preliminary phases, such as ESA's THOR and NASA's IMAP, will help elucidate how instabilities shape the evolution of the heliosphere.