



PARKER SOLAR PROBE

A MISSION TO TOUCH THE SUN

Inferred Linear Stability of Parker Solar Probe Observations using One- and Two-Component Proton Distributions

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Background: The hot and diffuse nature of the Sun's extended atmosphere allows it to persist in non-equilibrium states for long enough that wave-particle instabilities can arise, modifying the evolution of the expanding solar wind. Determining which instabilities act, and how significant a role they play in governing the dynamics of the solar wind, has been a decades-long process involving in situ observations at a variety of radial distances. With new measurements from Parker Solar Probe (PSP), we can study what wave modes are driven near the Sun, and compare to the instabilities predicted for the observed thermal plasma populations.

Method: We model two hours-long intervals of PSP/SPAN-i measurements of the proton phase-space density during PSP's fourth perihelion with the Sun using two commonly used descriptions for the underlying velocity distribution, treating the protons as either a relatively drifting beam-and-core distribution or a single bi-Maxwellian distribution with the same effective pressure parallel and perpendicular to the background magnetic field. The linear stability and growth rates associated with the two models are calculated and compared.

Results: We find that both intervals are susceptible to resonant instabilities with ion-scale frequencies comparable to those observed by PSP/Fields.

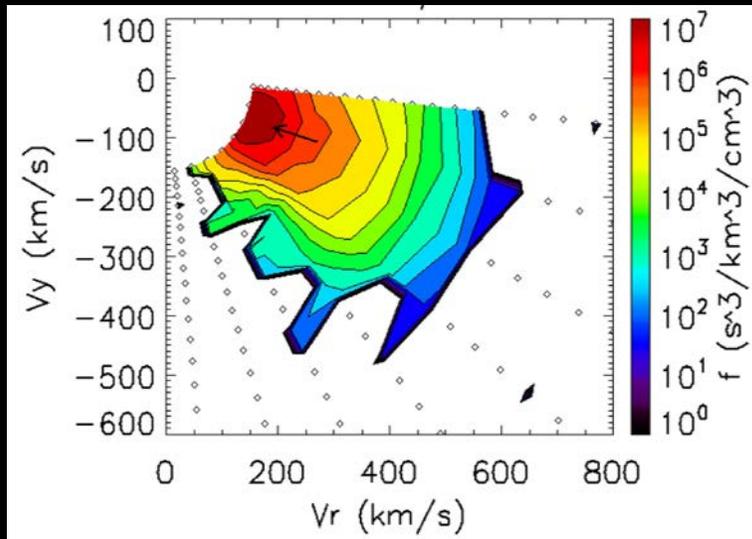
- The growth rates and kind of modes driven unstable vary depending on if the protons are modeled using one or two components. Accurate representations of proton velocity distributions as provided by PSP/SPAN-i enable more precise study of kinetic plasma processes.
- In some cases, the predicted growth rates are large enough to compete with other dynamic processes, such as the nonlinear turbulent transfer of energy, in contrast with relatively slower instabilities at larger radial distances from the Sun.



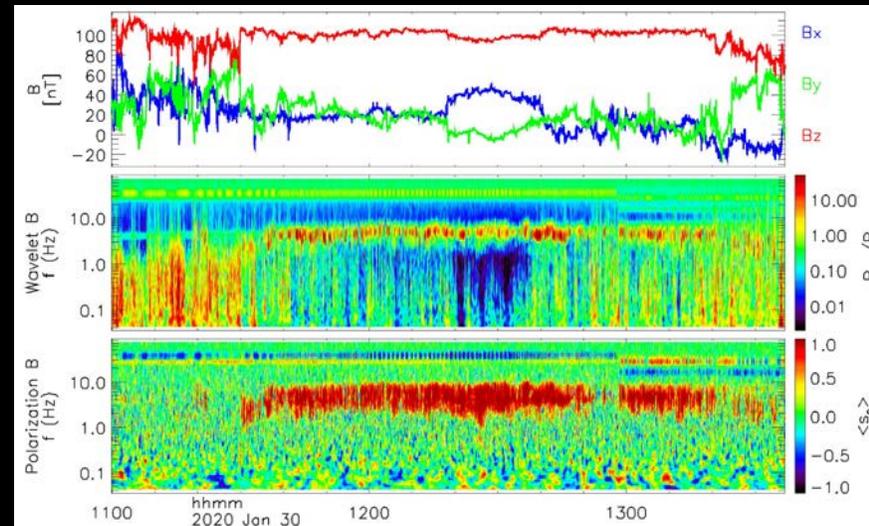
Ion-scale Waves Driven by Beams and Anisotropies in the Near-Sun Solar Wind



- Both ion-scale waves and non-Maxwellian thermal ion populations are observed by PSP.
- Considering the contribution of both the proton beam component and the proton core temperature anisotropy yields predicted growth rates and frequencies comparable to observations.
- Some instabilities are fast enough to compete with other processes, indicating that these departures from equilibrium may play a dynamic role in driving the evolution of the young solar wind.



SPAN-I proton distribution



Fields magnetic field characteristics

