Parametric decay instability of Alfven waves in the solar wind

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Using numerical simulations we investigate the onset and suppression of parametric decay instability (PDI) in the solar wind, focusing on the suppression effect by the wind acceleration and expansion. Wave propagation and dissipation from the coronal base to 1 au is solved numerically in a self-consistent manner; we take into account the feedback of wave energy and pressure in the background. Monochromatic waves with various injection frequencies, f_0, are injected to discuss the suppression of PDI, while broadband waves are applied to compare the numerical results with observation. We find that high-frequency (larger than 10^{-3} Hz) Alfven waves are subject to PDI. Meanwhile, the maximum growth rate of the PDI of low-frequency (lower than 10^{-4} Hz) Alfven waves becomes negative due to acceleration and expansion effects. Medium-frequency (around $10^{-3.5}$ Hz) Alfven waves have a positive growth rate but do not show the signature of PDI up to 1 au because the growth rate is too small. The medium-frequency waves experience neither PDI nor reflection so they propagate through the solar wind most efficiently. The solar wind is shown to possess a frequency-filtering mechanism with respect to Alfven waves. The simulations with broadband waves indicate that the observed trend of the density fluctuation is well explained by the evolution of PDI while the observed cross-helicity evolution is in agreement with low-frequency wave propagation.