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Equilibrium velocity distributions including the wave dynamics and nonlinear Alfven waves in the solar wind

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It is well known that low-frequency, finite amplitude Alfven waves are ubiquitously observed in the solar wind plasma. Damping process of the Alfven waves has been paid attention to, since it is believed that they play an important role in generating turbulent state and heating particles. When we focus on the wave dynamics, the fluctuations and structures with scales larger than those of the waves are usually treated as the background. On the other hand, the waves within the coarse-grained scale are usually removed or modeled through statistical average in global models of the solar wind. It is important that due to the broadband spectra and finite amplitude of the waves, the validity of such scale separations is not trivial in the solar wind plasma. For instance, while global solar wind models usually use the scalar pressure with the polytropic relation, the wave dynamics can be contained in the equilibrium velocity distribution (VDF), which should be defined at each grid point of the numerical model. As a consequence, the polytropic index do not need to be consistent with the adiabatic specific heat ratio (=5/3). In this presentation, consequences of the integrated VDFs including the wave dynamics are discussed. We revisit the polytropic relation of the solar wind ion in the presence of the finite amplitude waves at the coarse-grained scale. The stability analysis of the envelope modulated Alfven waves under the integrated VDFs is also demonstrated.