Higher-order spectra (bicoherence) of phase-space resolved plasma fluctuations reveal a nonlinear three-wave coupling between an ion acoustic pump wave and low phase-velocity kinetic perturbations in a weakly-collisional magnetized Argon gas discharge. These spectra are derived from the deviations of the photon statistics of multiple LIF signals from the Poisson statistics of an unperturbed plasma. A simple theory is presented for the plasma instability in terms of the kinetic spectrum of the 1-D Vlasov equation for the ions (assuming a Boltzmann response for the electrons). An alternate derivation based on the discrete spectrum of the weakly-collisional kinetic equation will also be presented and compared with the experimental data. These kinetic modes are analogous to the damped kinetic modes in plasma turbulence simulations.