Radial Velocity Variations in Pulsating Ap Star HR 1217

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In this paper we present the first results of high-precision radial velocity (RV) study of the rapidly oscillating Ap (roAp) star HR 1217. Data were acquired on 12 nights in late 1997/1998 using the Harlan J. Smith 2.7m telescope at McDonald Observatory and these span a complete rotation period of the star. The RV was measured over the spectral range ~100Å of a spectral order of the 2D-coudé echélle spectrograph. Most of the pulsational modes can be seen in all spectral regions. The amplitude varies by factors of at least ten between the different wavelength intervals. The largest pulsational amplitudes are seen in spectral regions 5650 − 5830Å and 5000 −5200Å. The lowest pulsational amplitudes are seen in intervals 5900 − 6000Å and 6200 − 6300Å. We also see strong rotational modulation in both the amplitude and phase of the pulsation modes. The largest RV amplitudes are found at rotation phases 0.8 − 1.30 which coincides with magnetic maximum. Phase jumps of the $f_2 = 229.06c/d$ (2652.9μHz) mode is seen at rotation phases 0.45 and 0.95. A detailed analysis of the spectral order containing the region 5776 − 5873Å, which had the largest amplitudes, showed the presence of all published photometric frequencies. All modes were also found in the RV variations of the high amplitude Nd III 5294.1Å feature. Our RV data reveal two new excited modes at frequencies $223.29c/d$ (2584.9μHz) and $220.44c/d$ (2251.4μHz) that follow the odd and even alternative mode spacing with the $\Delta\nu_0/2 \simeq 34$ μHz. An analysis of individual nights show the strong amplitude and phase modulation of all excited modes including the two new ones. The amplitudes of f_2 and f_4 modes are modulated with the published magnetic field variations and reach their maximum and minimum respectively at magnetic extrema. However the phase variability is in disagreement with that expected from the idealized oblique pulsator model and in spite of non-reversive character the magnetic field variations the phase jumps occur exactly at magnetic maximum and close to the phase of magnetic minimum. The amplitude and phase variability of other modes are more complicated. We compare the modelled and observed phase and amplitude varibility of pulsation modes and show that the phase variability could not be explained by pure zonal modes or linear combination of magnetically distorted (l, $m=0$) zonal components. We attribute the peculiar phase variability to strong vertical atmospheric changes of pulsation phase and changes of line formation depth from magnetic pole to equator.

We constructed echélle-diagram for all known excited modes in HR 1217 modes and give an interperetation of "peculiar" spacing of f_7 mode with respect to the other modes. We relate the f_7 mode to one of degree $l = 4$ that forms another frequency spacing of modes related to odd and even degrees. We predict, the existence of another sequence of modes, yet undetected, that should be equally spaced at 68 μHz or 34 μHz with the f_7 one.