Unexpected frequency-sweep reverse of subelements in chorus rising tone

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Nonlinear resonance between energetic electrons and chorus waves is widely used to explain the frequency sweep of chorus, which predicts that rising tone elements are comprised by multiple subpackets with the frequency gradually increasing. Here we report two events that subelements with their frequencies downward chirping occur in rising tone chorus. The duration of those subelements is comparable with the regular subpackets, and their frequency sweep rates 6-12 kHz/s are consistent with previous theory and observations. Waveform of the subelement shows similar morphology to regular chorus element, consisting several finer structures "hyper-subpackets". We propose a possible scenario that the falling tone subelements are formed by nonlinear process with much shorter timescale. The starting frequency of each subelement controlled by the linear growth phase increases may because the electron distribution varies fast. This study provides new insight on chorus generation and also brings challenges.