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Observation of oblique lower band chorus waves, and discussion of chorus source properties

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We report observations of lower band chorus emissions by WBD and STAFF instruments recorded onboard CLUSTER spacecraft on 20 January 2004. Analysis of data from both the WBD and STAFF instruments shows that chorus emissions were generated with highly oblique angles in this case. Moreover, we observed remarkable time shifts and frequency differences between the corresponding elements recorded by different CLUSTER spacecraft. Surprisingly, the spacecraft located closer to the geomagnetic equator systematically received the corresponding chorus elements later than the spacecraft located at higher magnetic latitudes. The Poynting flux measurements made by the STAFF instrument confirm that the chorus source is located in the magnetic equatorial plane. Owing to the orbit, the spacecraft located closer to the equator were at lower L-shells during these observations. The time shifts and frequency differences depended almost linearly on the perpendicular distance between the various spacecraft. We discuss several properties of the chorus source that could lead to these observations. We show that the sources moving across the magnetic field lines are reasonably well consistent with these observations. We propose that the transverse motion of the chorus sources is a consequence of a feedback between the oblique waves and counter streaming electrons during nonlinear cyclotron interactions, and we provide an estimation of the transverse velocity of the source.