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Supporting Information for

Revealing the Local Time Structure of the Alfvén Radius in Jupiter's Magnetosphere through High-resolution Simulations

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Contents of Supporting Information

Descriptions (Titles) for Videos S1 to S5

Video S1. The movie of the simulation results showing the dynamic variations of the (left panel) plasma radial velocity V_r, (middle panel) plasma Alfvén velocity V_A, and (right panel) V_r - V_A on the equatorial plane corresponding to Figure 1 in the main text. The movie top title shows the corresponding simulation time.

Video S2. The movie of the simulation results showing the dynamic variations of V_r - V_A on the equatorial plane corresponding to Figure 2 in the main text, which presents the dynamic variations of the Alfvén radius at one hour intervals for four different times. The titles of each panel in the movie show the corresponding simulation times.

Video S3. The movie of the simulation results showing the characteristics of the (left panel) plasma radial velocity V_r, (middle panel) plasma Alfvén velocity V_A, and (right panel) V_r - V_A on the equatorial plane after 10 hr averaging, corresponding to Figure 5 in the main text. The title in the movie shows the averaged 10 hr time interval as well as the ongoing evolution.

Video S4. The movie of the 20 hr-averaged simulation results, in the same format of Video S3.

Video S5. The movie of the 40 hr-averaged simulation results, in the same format of Video S3.

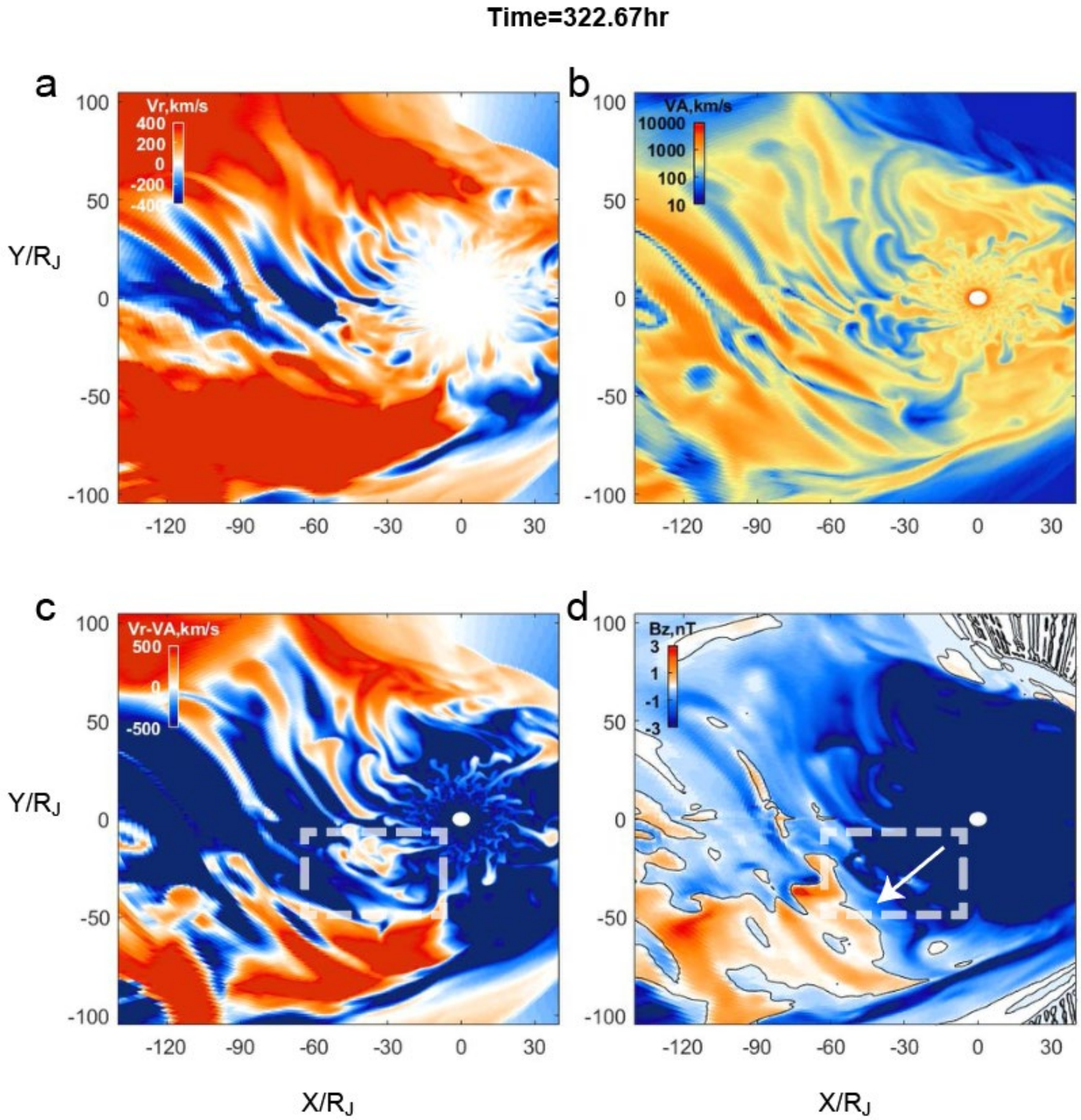

Figure S1. The distribution of the (a) plasma radial velocity V_r, (b) the distribution of the plasma Alfvén velocity V_A, (c) the distribution of $V_r - V_A$ and (d) B_z on the equatorial plane at ST = 322.67 hr corresponding to Figure 2a. Because the dipole tilt angle is set to zero in the simulation, the distribution of B_z is instrumental in identifying the magnetic reconnections within the magnetotail. Specifically, the black contour in panel (d), where B_z equals zero, aids in pinpointing the location of the X-line. A distinct distribution of the Alfvén radius (indicated by the white dashed box in panel c) is located obviously inside the reconnection X-line indicated by the white arrow.

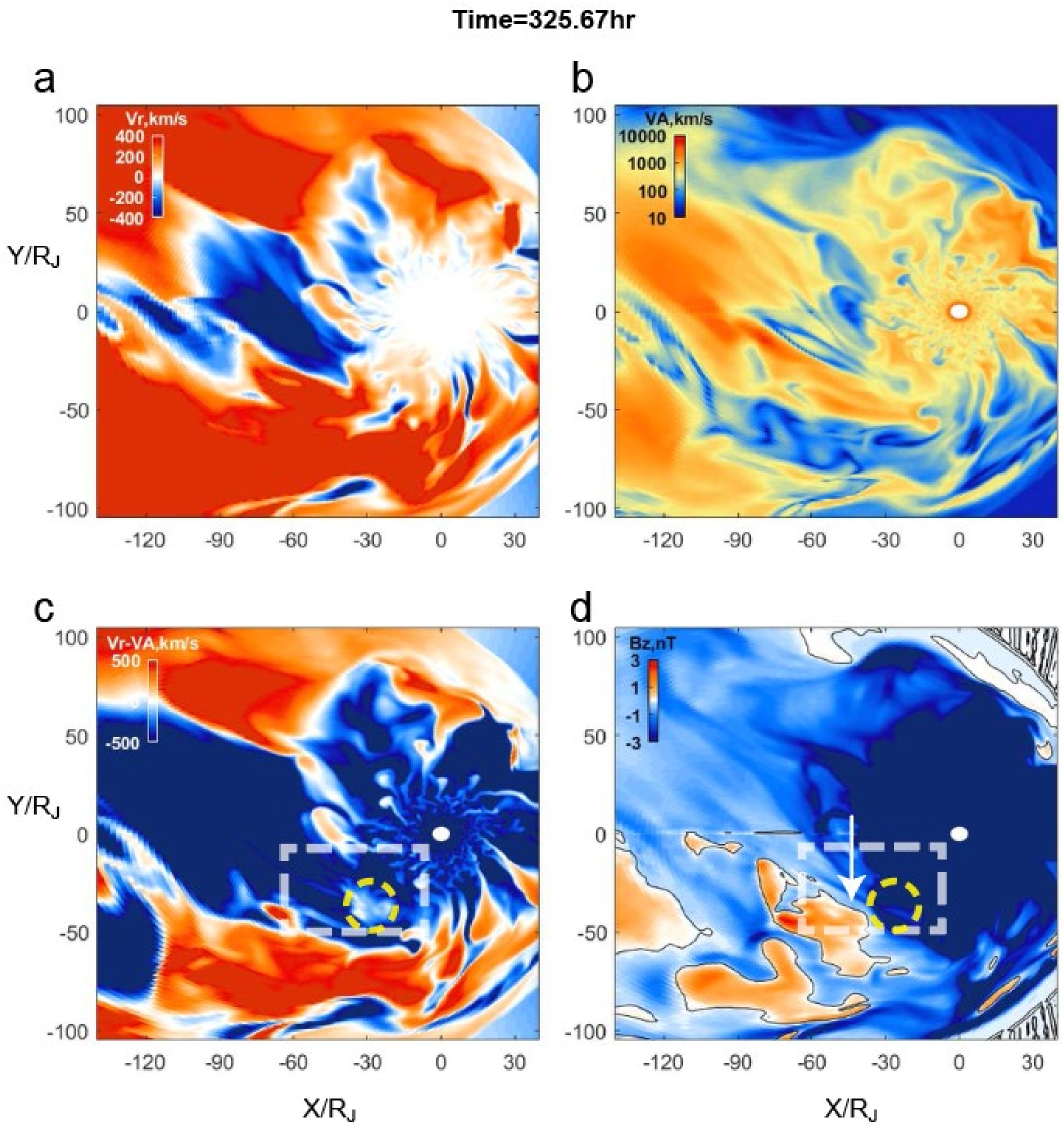

Figure S2. The distribution of the (a) plasma radial velocity V_r, (b) the distribution of the plasma Alfvén velocity V_A, (c) the distribution of $V_r - V_A$ and (d) Bz on the equatorial plane at ST = 325.67 hr, 3 hours after Figure S1, corresponding to Figure 2d. The Alfvén radius moves azimuthally to the morning side and the Alfvén radius distribution in the white box becomes very weak, presenting a stark contrast to its state three hours earlier. At this moment, the X-line moves inward closer to the Alfvén Radius, but is still outside the weak Alfvén Radius, as shown by the yellow circles in (c,d) panels pointing to the position of the Alfvén radius and the white arrows in (d) panel.

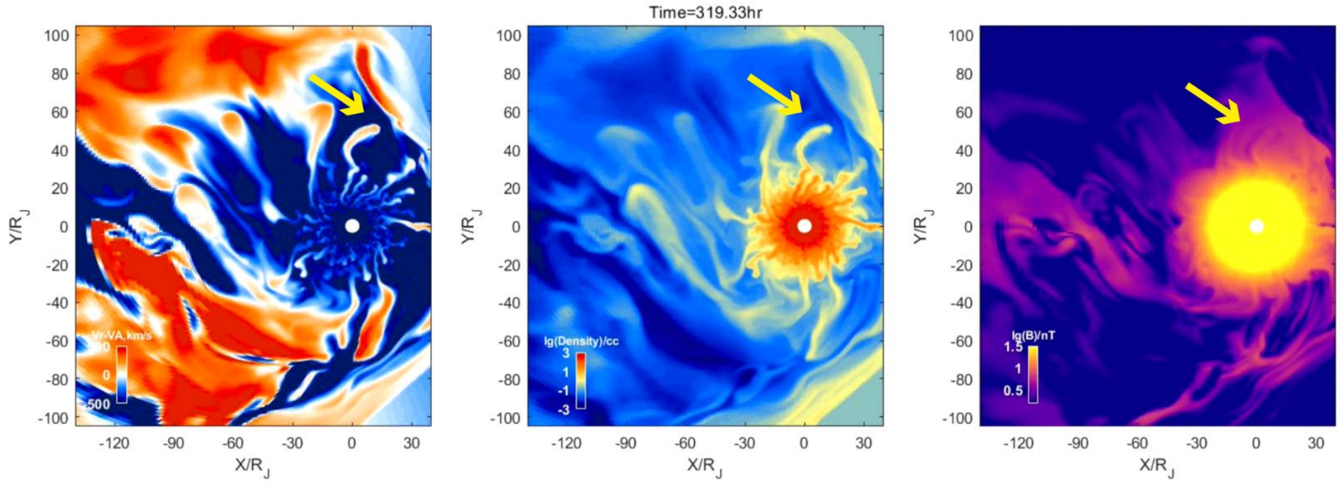

Figure S3. Potential evidence in the simulation linking small structure of Alfvén radius and interchange instability in the Jovian magnetosphere. The left panel show the Alfvén radius complex structure; The middle panel shows plasma number density; The right panel shows the magnetic field magnitude, the black parts indicating the regions with small magnetic field. The yellow arrows point to flux tube features associated with interchange instability - sharp density cavities (middle panel) and abrupt changes in the magnetic field (right panel), which is in the same location as the small structure of the Alfvén radius.

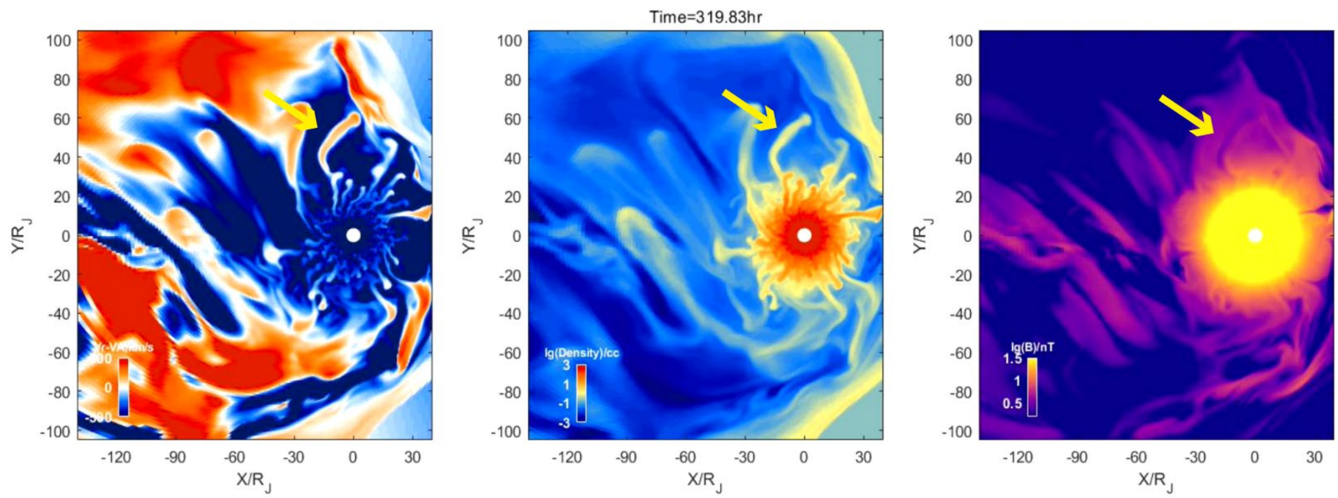

Figure S4. The simulation results of the structure 0.5 hr after Figure S3, using the same format as Figure S3. The structures of interchange instability, indicated by the yellow arrows, rotates counterclockwise due to the modulation by planetary rotation compared to Figure S3, which is consistent with that Jupiter's magnetospheric interchange instability is driven by centrifugal forces.

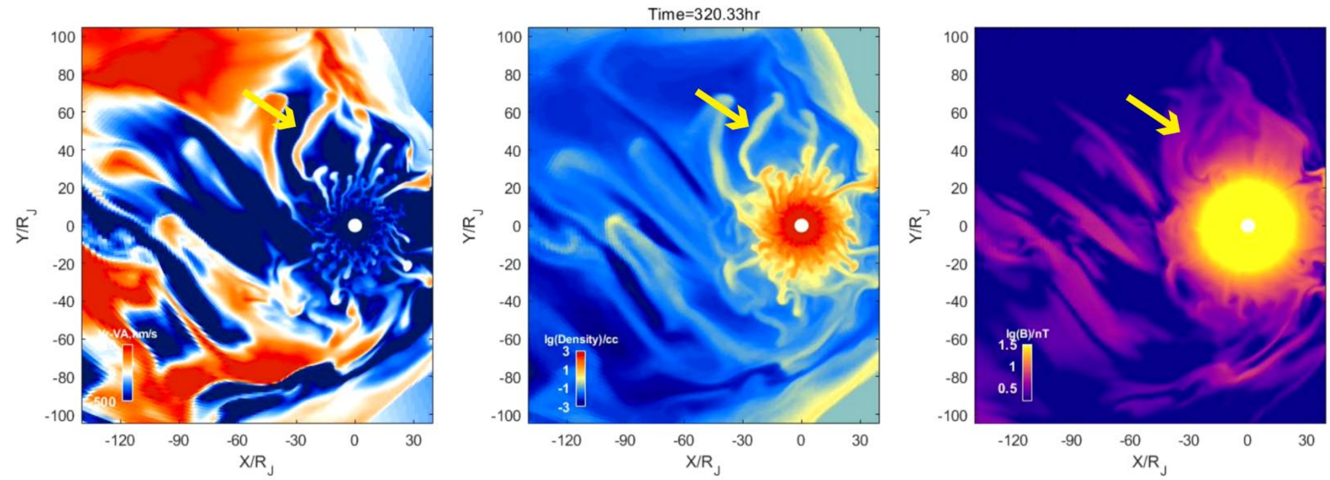

Figure S5. The simulation results of the structure 1 hr after Figure S3, using the same format as Figure S3. Similarly, the structures of interchange instability, indicated by the yellow arrows, rotates counterclockwise due to the modulation by planetary rotation compared to Figure S4.