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A new mechanism for the flapping motions of Earth's magnetotail current sheet

Z. J. Rong[1] , J. W. Gao[1], C. Shen[2], Y. H. Cai[1], A. A. Petrukovich[3], A. T. Y. Lui[4] , M. W. Dunlop[5, 6] , Y. Wei[1], and W. X. Wan[1]

[1]Key Laboratory of Earth and Planetary Physics, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China, [2]Harbin Institute of Technology, Shenzhen, China, [3]Space Research Institute, Russian Academy of Sciences, Moscow, Russia,[4]Applied Physics Laboratory, The Johns Hopkins University, Laurel, MD, USA, [5]Space Science Institute, School of Astronautics, Beihang University, Beijing, China, [6]RAL, Chilton, Oxfordshire, UK

E-mail: rongzhaojin@mail.iggcas.ac.cn

The flapping motion of magnetotail current sheet, manifesting as the multiple crossings of current sheet by spacecraft, is a common dynamic phenomenon of space plasma, which is widely observed in planetary magnetotails [Shen et al.,2008;Rong et al.,2010;Rong et al.,2015a,2015b;Gao et al.,2018; Rong et al.,2018 and references therein].

Many studies demonstrated that the flapping motion in Earth magnetotail can propagate as kink-like waves from the midnight region toward both magnetotail flanks, with a velocity of several tens of km/s [Zhang et al., 2002; Sergeev et al., 2004; Shen et al., 2008]. The sources around the midnight to trigger the kink-like flapping motion, however, remains unclear although many models and theories have been proposed.

Recent study suggested that the flapping motion has two types, that is, kink-like flapping and steady flapping [Rong et al., 2015b]. The steady flapping motion refers to that the tail CS sometimes just flaps up and down but does not propagate as king-like waves.

Most previous studies are focused on the kink-like flapping, and steady flapping has received less attention. A more reasonable flapping mechanism should have to consider how the two flapping types relate to each other and how to incorporate them into a global picture of magnetotail flapping motion.

In this study, we survey the spatial distributions of both flapping types of Earth magnetotail based on the Cluster multipoint measurement. As shown in Figure 1, we found that the midnight region is dominated by the up-down steady flapping motion, and kink-like flapping tends to occur at both flanks of magnetotail. Thus, the distribution of flapping types suggests a new flapping mechanism that the up and down motion of steady flapping around the midnight region induces kink-like flapping waves, which propagate toward both flanks of the magnetotail.

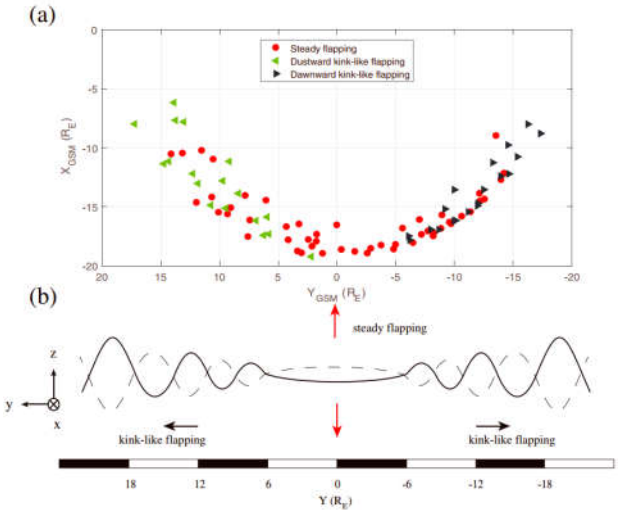

Fig.1. (a) Locations of the surveyed flapping cases in the Y-Z plane. (b) Schematic views of the global flapping motion of the Earth's magnetotail current sheet.

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