PEM05-27 Room:303 Time:May 21 14:45-15:00

Misleading of Dungey's convection

Takashi Tanaka[1*]

[1]Emeritus Professor, Kyushu University

Magnetosphere-ionosphere (M-I) convection is the magnetohydrodynamic (MHD) motion maintained against the dissipation caused by the ionospheric current system. Primary energy to replenish the ionospheric dissipation is, without any doubt, the solar wind motional energy. In the M-I coupling flow, the magnetospheric motion is transmitted to the ionosphere by the field-aligned current (FAC) to maintain the ionospheric convection potential. The central problem is, therefore, how the solar wind motional energy is converted inside the magnetopshere to the electromagneic energy of the FAC. Energy conversion process acts between three types of energy, flow motional energy, plasma thermal energy, and the electromagnetic energy. Whereas the general physics ruling these energy conversion is well known, it is not easy to know how, where, and which energy conversion acts in the real configuration of the huge magnetosphere. So that the understanding has not progressed from the cartoons such as the Dungey convection, the Bostrom current, and the current wedge. In recent years, however, the problem is becoming definitely accessible from the development of three dimensional (3D) M-I coupling simulation. Now, we can draw the distributions of energy conversion rate between three kinds of energy, and can trace current lines.

From the simulation results, five electromagnetic energy conversion layers are identified in the magnetosphere, (1) the bow shock, (2) dayside magnetopause-low-latitude cusp, (3) high-latitude cusp-mantle, (4) the plasma sheet, and (5) the inner magetosphere. The first layer is at the bow shock, where flow motional energy is the driver of the energy conversion. Here we refer the energy associated with the force that does the work for the energy conversion as the driver, and the energy associated with the counter force as the acquire. At the bow shock, most of driving energy (flow motional energy) is converted to thermal energy with some to electromagnetic energy. This configuration is quite reasonable with respect to the nature of the fast shock. The second is at the dayside magnetopause-low-latitude cusp, where magnetic tension released on the dayside is the driver of energy conversion (J.E>0). This driving energy is mainly converted to thermal energy with a little to flow motional energy. The second energy conversion layer on the dayside magnetopause continuously extends to the low-latitude side of the cusp and deposits generated thermal energy to the cusp. Flow motional energy generated in the second layer (it can be called the Dungey flow) is lost and converted to thermal energy through the flow braking, before reaching the cusp. The third energy conversion layer is on the high-latitude side of the cusp to the mantle. Here, thermal energy (driver) is converted to electromagnetic energy (acquire) to generate the region 1 FAC (J.E<0), and equivalently the magnetospheric convection. Strict overapping is seen between this dynamo layer and the layer in which thermal energy is the driver. These results indicate that the dynamo is driven by the flow crossing pressure gradient and the region 1 FAC is closed by diamagnetic current inside the dynamo.

From the Dungey convection, we first get an image of excitation of convection by the magnetic force. This image must result in the driver layer by electromagnetic energy that overlaps with acquire layer for flow motional energy. If such layer is distributing all over the magnetosphere, it may be just the Dungey convection. In the simulation results, however, such layer distributes only in a narrow region along the dayside magnetopause. The second image from Dungey convection is the dynamo driven by the solar wind motional enrgy, namely the driver layer by the flow motional energy that coinsides with acquire layer for the electromagnetic energy. For this configuration, inertial current will close the FAC. In the simulation results, neither of these two estimation is realized.

Keywords: convection