Understanding the behavior of charged particles in plasma by vector potential

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Geomagnetism is caused by the movement of charged particles. If the magnetic field is assumed at first, the effect of protons in solar wind on the Earth will be ignored. Because electrons are affected by the magnetic field and the electrons act as repulsive forces to protons. However, in practice, the behavior of protons will affect the motion of electrons. Aharonov–Bohm effect indicates that motion of particles must be considered first in a plasma. In a superconducting magnet, moving electrons are covered with positive ion lattice vibrations and the positive charges of vibration together with electrons and the lattice vibrations emits vector potentials. Although the magnetic field by the lattice vibration offsets internally, it exhibits a magnetic levitation [1].
The electrostatic potential (V) gives energy (U=q・V) for a charge (q), while the vector potential (**A**) gives energy (U= - **i** ・**A**) for a current (**i**). Since a line integral of (**B**) becomes **A**, **B**= rot **A**. Since d**B**/dt=- rot **E**, we get d**A**/dt=- **E**. In high-speed charged particles running side by side, if the polarity is the same particles, they attract each other as parallel currents, and when the polarity is different, they repel with anti-parallel currents. In the Sun's plasma, charged particles of high-speed motion create a structure. But the Sun has an escape rate of 617.5 km/sec, and most of the charged particles are pulled back by gravity to form an arc.
The Earth has Van Allen radiation belt, which consists of outer belt, slot region and inner belt. In addition, there is another slot region between the inner belt and ionosphere. Such layered structure is formed by high-speed charged particles.
Earth's gravity can't hold hydrogen. The Sun's electromagnetic waves ionize nitrogen and oxygen at the daytime hemisphere to form the ionosphere. The ionosphere with a lot of free electrons orbits the Earth, and it will form the geomagnetism. On the other hand, Jupiter and Saturn are covered with hydrogen, and hydrogen ions of the solar wind invade, and the atmosphere containing a lot of positive ions rotates counterclockwise direction. So, the geomagntism of Jupter and Saturn is oposite to the Earth.
On the Earth, auroras occur in the annular region around 75 degrees in the daytime hemisphere of the Earth and 65 degrees on the nighttime hemisphere. On the daytime hemisphere where there are many electrons generated by X-rays and ultraviolet rays from the Sun, auroral emission is weak and the area where auroras occur moves to the high latitude side. The area where the geomagnetic magnetic force line enters the ground perpendicularly is off the polar axis and it is an annular shape. The aurora always shakes. Such geomagnetism is not caused by the movement of material in the Earth's interior, but the current of electrons induced in the Earth's interior contributes to the geomagnetism.
[1] S. Karasawa, "Mechanism of superconducting magnet”, 2021, 3/Feb, https://www.youtube.com/watch?v=-ETMJ0Pr-8w

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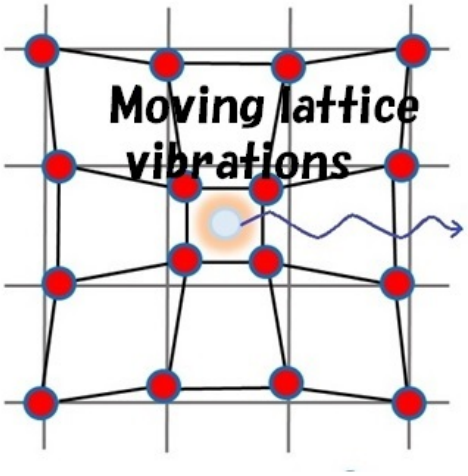
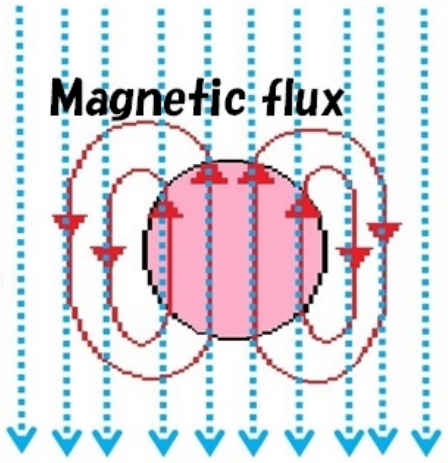
Mechanism of *superconducting magnet*





The principle of superconductivity has been elucidated by quantum mechanics, but the mechanism of superconducting magnets has not yet been elucidated. However, we are able to understand the mechanism by thinking about behaviors of charged particles involved.

