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観測結果に基づいた太陽静穏領域磁極の磁気化学方程式数値計算
Numerical calculation of magneto-chemistry equation based on the observational results in quiet regions of the Sun

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We report the results of numerical calculation of magneto-chemistry equation (Schrijver et al., 1997) based on the observed frequencies of merging, splitting, emergence, and cancellation of photospheric magnetic patches in a quiet regions on the Sun.

Parnell et al. (2009) reports the power-law frequency distribution of flux content in magnetic patches with an index of -1.85, which spans from sunspots in active regions to small patches in quiet regions. Two ideas for the explanation of this distribution were suggested: One is that the distribution reflects dependence of flux supply from below the photosphere. Another is that surface magnetic processes maintain the distribution.

The surface processes of the photospheric magnetic field consist of merging, splitting, emergence and cancellation of magnetic patches. We investigated frequencies of these processes by observations of two quiet regions and suggest a qualitative picture of the flux maintenance. It is: 1) Frequency distribution of flux content is dominantly maintained by merging and splitting. 2) Cancellation occurs owing to the random motion of the convection. 3) The flux submerged through a cancellation re-emerges and is recycled to the surface.

The next step is a quantitative investigation for finding a stable equilibrium solution based on these observations, which is our topic in this study. We solve numerically the magneto-chemistry equation, which is suggested by Schrijver et al. (1997) and describe relationship among frequency distribution of flux content and those of magnetic processes. It should be noted that we use an assumption of flux recycling of submerged flux.

We obtain the results that: 1) The frequency distribution reaches a stable equilibrium, which is a power-law distribution with an index of -1.7. 2) The equilibrium solution strongly depends on the input values of the frequencies of magnetic processes. 3) The equilibrium is independent of initial conditions. These results indicate that the observed surface processes can make and maintain the observed frequency distribution of flux content with recycling of magnetic flux in a quantitative sense.

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