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N-S asymmetry of the photospheric magnetic field: relation with the positive and negative flux imbalance

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Photospheric magnetic fields are studied using Kitt Peak synoptic maps for 1976-2003. Only strong magnetic fields (B> 100 G) of the equatorial region (heliolatitudes from -40° to +40°) were taken into account. North-South (N-S) asymmetry of the magnetic fluxes is considered as well as the imbalance between the positive and the negative fluxes.

N-S asymmetry of the magnetic field displays a regular alternation of the dominating hemispheres. On the ascending phase (from the solar activity minimum to the inversion of the Sun's global magnetic field) the N-hemisphere always dominates. During the inversion the dominating role passes to the S-hemisphere which prevails up to the next minimum.

For each of the Sun's hemispheres (from 0° to +40° and from 0° to -40°) the difference between the positive and the negative fluxes (the imbalance) shows systematic changes closely related to the 22-year magnetic cycle. The sign of the imbalance coincides with the sign of the leading sunspots in the given hemisphere, which suggests the domination of the flux of the leading sunspots over the flux of the following ones.

If we consider both hemispheres together (from -40° to +40°) the imbalance also changes with the 22-year period, yet the imbalance changes its sign during the period of the magnetic field inversion. The sign of the imbalance does not change during 11 years from one inversion to the other and always coincides with the sign of the Sun's global magnetic field in the N-hemisphere.

The domination of leading sunspots in one of the hemispheres determines the sign of the magnetic flux imbalance. During 11 years from one inversion to another the main contribution to the net flux is made by the leading sunspots of the polarity which coincides with the sign of the Sun's global magnetic field in the N-hemisphere. Thus, during the solar activity minimum when the leading and the following sunspots change their signs according to Hale's law, domination of the leading sunspots of certain polarity remains unchanged. Before the minimum the leading sunspots of the S-hemisphere dominate, while after the minimum the leading sunspots of the N-hemisphere play the dominating role.

Both the sign of the N-S asymmetry of the magnetic fluxes and the sign of the imbalance of the positive and the negative fluxes are related to the quarter of the 22-year magnetic cycle where the magnetic configuration of the Sun remains constant (from the minimum where the sunspot sign changes by Hale's law to the magnetic field inversion and from the inversion to the minimum).

The sign of the N-S asymmetry is determined by the phase of the 11-year cycle (before or after the inversion); the sign of the imbalance of the positive and the negative fluxes depends both on the phase of the 11-year cycle and on the parity of the solar cycle. The obtained results demonstrate the connection of the magnetic fields in active regions with the Sun's global magnetic field in the N-hemisphere.