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The magnetic field generated by sources inside and outside the star

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Abstract. The magneto-sensitive atmosphere of a star is an ideal detector of the magnetic field penetrating the atmosphere layer – indifferently from which side. Most magnetic stars possess their own magnetic moment in its interior, neglecting the possibility of externally caused influence of magnetic fields. Only inner or nearby powerful magnetic sources may influence recognizably the atmosphere of a star with a sufficiently large surface. An externally influenced magnetic field can be found at a binary system consisting of a non-magnetic giant with a magnetic dwarf companion.[1]

Key words: Magnetic stars – magnetic fields – modelling – star: ν Cep

1. Sources and vortices

Since magnetic fields are bound to moving electrically charged particles, whose path of propagation is surrounded by circularly closed lines of power, there do not exist real magnetic sources. A physically more suitable description of magnetic fields would be given by the vortex calculus. After a theorem of the potential theory, every stationary vector field consists of the superposed fields emerging from sources and vortices. Both sources and vortices form – by according combination – dipoles with a magnetic moment as an axial vector. The superposition of the fields of a positive and a negative "magnetic charge" of equal quantities produces a magnetic dipole, which is analog to an electrical dipole and is physically reasonable. Such magnetic dipoles are the elementary "bricks" of a space-filling composed magnetic field – inside and outside the star.

1.1. Inside the star

The "magnetic charges" may be positioned anywhere in the interior of the star, forming a pattern of spatially distributed point sources. The charges are members of dipole pairs, rendering the sum of all positive and negative charges zero. By combination of dipoles every field structure might be constructed. The dipoles need not to be centered in the middle of the star. The normal case would even be the deviation from the central symmetry: the decentered dipole.

[1]Poster representation at CP#AP WORKSHOP, 10-14 September 2007, Observatory of the University Vienna, Austria. Original poster available by www.ewald-gerth.de/121pos.pdf.

1.2. Outside the star

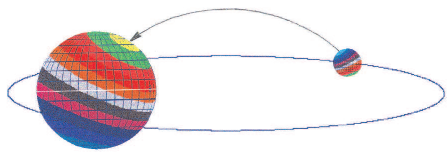
The magnetic field of a star becomes evident only at its surface, from which we can conclude on the field structure in the surrounding space by extrapolation. Such a field can influence a body in the vicinity like an orbiting companion. Therefore, also the reverse constellation is possible. We observe predominantly the star of the binary with the brighter luminosity and the larger surface, which could be the non-magnetic primary star. At such a star we can expect and prove the following phenomena:

1. The rotation of the star derived from $v \sin i$ and the brightness variation do not agree.
2. The periods of the variations of radial velocity and effective magnetic field strength have a relation of 2:1 .
3. In case of an elliptical orbit the phase curves are not equal, pretending thus another than the true surface structure.

A lot of further conclusions could be drawn, especially concerning other astronomical systems with mutual magnetic influence. All this is calculable under the assumption of magnetic sources outside the star.

2. The "magnetic" supergiant star ν Cep

Magnetic fields are commonly attributed as a property to a star itself. The possibility, that the field comes from outside the star, has not been considered yet. In contrast to all expectations, the striking observation (made by G. Scholz in 1978) of a strong magnetic field of +2000 G in the supergiant A2Ia star ν Cep (HD 207260), which cannot retain an own magnetic field because of field-destroying processes like convection (Gerth 1988), could not be arranged reasonably and led to the assumption, that we observe at this star the influenced external magnetic field of a companion in a close binary system. Thus, this interesting object can be considered as a prototype of a star with an **indirect magnetic field** – as demonstrated schematically:



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