The magnetic field generated by sources inside and outside the star

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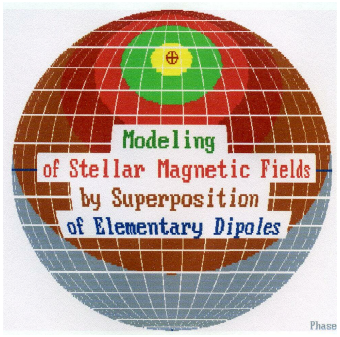


Superposed magnetic monopoles. Poster-representation at the IAU Symposium 210 in Uppsala, Sweden, 17-21 June 2002 Ref.: www.ewald-gerth.de/102pos.pdf

The ubiquitously in universe present magnetic fields reveal themselves only by **interaction** with the interspersed material by the Faraday and the Zeeman effects.

The **magneto-sensitive atmosphere** of a star is an ideal detector of the magnetic field penetrating the atmosphere layer - indifferently from which side.

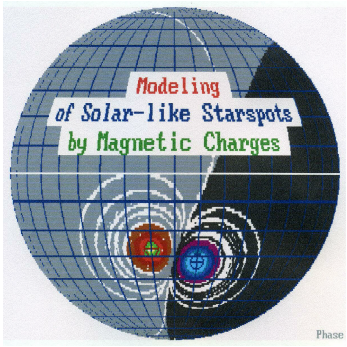
Most magnetic stars possess their own **magnetic moment** in its interior, neglecting the possibility of externally caused influence of magnetic fields.

Only inner or nearby **powerful magnetic sources** may influence recognizable 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.

Further possibilities of external magnetic sources should be taken into consideration, such as close and cataclysmic binary systems with **mutual influence**.

We demonstrate here only the principal possibilities and relate to the advantages of the theoretical, mathematical and numerical treatment of the construction of magnetic fields by **sources** and **vortices**.



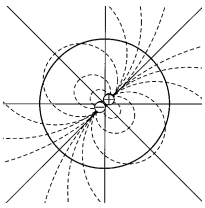
Starspot, constructed by a dipole (or vortex !) under the surface. Poster-representation at IAU Symposium 210 in Uppsala, Sweden, 17-21 June 2002. Ref.: www.ewald-gerth.de/103pos.pdf

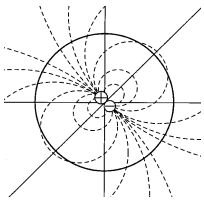
Sources www.ewald-gerth.de/105pos.pdf Vortices

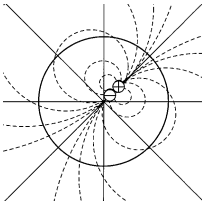
Since magnetic fields are bound to moving electrically charged particles, whose path of propagation is surrounded by circularly **closed lines of power**, there do not exist real magnetic sources comparable with electrical charges of electrical fields. The physically more suitable description of magnetic 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 of each – dipoles with a magnetic moment as an axial vector.

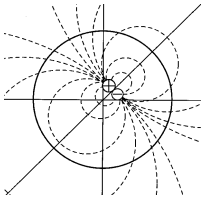
It is only a matter of mathematical-numerical convenience, that we introduce ***virtual magnetic charges*** as the outflow of the magnetic field from point-like sources. Thus, a standard algorithm can be used for the superposed fields of numerous sources. The superposition of the fields of a positive and a negative "magnetic charge" of equal quantity produces a magnetic dipole, which is analog to an electrical dipole and is physically reasonable.

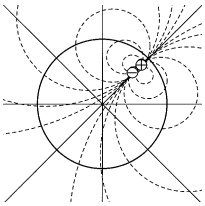
Such **magnetic dipoles** are the bricks of a space-filling **composed magnetic field** – inside and outside the star.

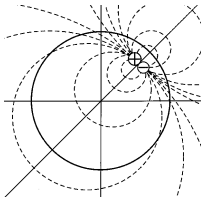


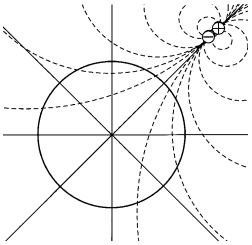


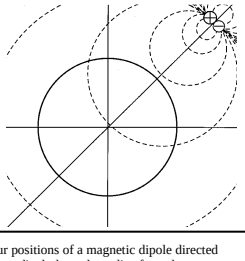












Four positions of a magnetic dipole directed radially from the center to the outside space Ref.: www.ewald-gerth.de/116pos.pdf

Four positions of a magnetic dipole directed perpendicularly to the radius from the center. Ref.: www.ewald-gerth.de/116pos.pdf

inside

The "magnetic charges" may be positioned anywhere in the interior of the star, forming a pattern of spatially distributed point sources. In respect to physics, all charges should be members of dipole pairs, rendering the sum of all positive and negative charges zero. The distance between the more or less divided dipole members is arbitrary but should be chosen deliberately by fitting to the desired field configuration. 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.

The geometrical limitation of the dipole arrangement is given, of course, by the star's surface, because the circulating electrical currents of the magnetic dipole flow only inside the star.

outside

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. 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:

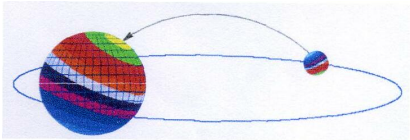
1. The rotation of the star derived from *v*sin*i* and the brightness variation do not agree.
2. The periods of the variations of radial velocity and effective magnetic field strength have a relation of 2:1 .
3. In case of an elliptical orbit the phase curves are not equal, pretending thus another surface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

the "magnetic" supergiant star *ν*Cep

Indeed, 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 hitherto. However, 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 possess or retain an own magnetic field because of field-destroying processes like convection, 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.

The above formulated criteria for an outside magnetic source are indicated in the observational results and should be proven by further observation. Thus and then, this interesting star can be considered as a prototype of a star with an indirect magnetic field – comparable with the moonlight borrowed from the sun and given away.



Schematic arrangement of a binary system with a non-magnetic primary star and a magnetic companion on orbit. Figure taken from poster: www.ewald-gerth.de/108pos.pdf

References

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The character of the "magnetic star" ***ν*Cep** as an externally inflenced star is considered first in
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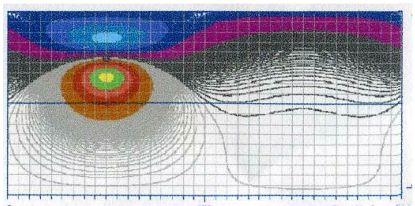

Mercator-map with iso-magnetic areas and lines according to the upper constellation of an external dipole arranged perpendicularly to the direction of the radius. Ref.: www.ewald-gerth.de/116pos.pdf

Poster representation at CP#AP WORKSHOP, 10-14 September 2007, Observatory of the University Vienna, Austria