Astron. Nachr./AN **32X** (200X) X, XXX–XXX

Magnetic Field and Radial Velocity Observations of the A2p Star 52 Her – Favoring a Precessional Model ⋆

E. GERTH

Central Institute of Astrophysics Potsdam, Telegrafenberg⋆⋆,
Private address: D-14471 Potsdam, Gontardstr 130, Germany.
e-mail: `ewald-gerth@t-online.de`

Received *date will be inserted by the editor*; accepted *date will be inserted by the editor*

Abstract. The magnetic A2p star 52 Her (HD 152107) has been investigated in the Central Institute of Astrophysics of the GDR since 1971. Spectroscopic observations secured on nearly 200 photographic Zeeman-spectrograms were carried out in Tautenburg, Zelenchuk, and Rozhen. All plates were measured on the Modified Abbe-comparator and evaluated in Potsdam. Besides of the magnetic field strength in every possible case the radial velocity has been determined. In the time interval of 15 years both magnitudes show short-periodic and evidently secular variations with modulation effects correlated to each other, which hint at a kinematic cause. For the explanation of the observational results a precessional model is proposed.

Key words: Chemically peculiar stars, magnetic fields, 52 Her, precession

1. Introduction

The peculiar A2 star 52 Her is one of the magnetic stars that have been investigated since BABCOCK's [1958] pioneering work on stellar magnetism, in which the first notice concerning this star is given:

Plate No	Date	B[Gauss]	RV[km/s]
Ce 5662	Jun.9.1949	+840+88	-0.2+0.4
Ce 9704	Jun.5.1955	+1430+83	1.7+0.4

Despite a considerable magnetic field strength proved to be significant with a remarkable inner accuracy by 100 Gauss, the difference of the two values quoted above was assessed to be periodical or random because of the influence of different observational conditions, but it was assumed, that the star exhibits monotonically a positive polarity. It should be noticed that already at the very beginning of observing magnetic stars besides of the magnetic field strength the radial velocity was measured. That time it was still too early for any statements on the kind of variability and the underlying physical processes, but the clearly different magnetic values could suggest a behavior alike an oblique rotator as later having become obvious for some other magnetic stars, namely 53 Cam, βCrB, α^2CVn.

Usually such a motion is connected with the rotation of the star. For a single star variations of the radial velocity can only be observed in the case of an inhomogeneous distribution of the radiation sources over the star's surface, which could be recognized in the phase relations of various magnitudes. On the other hand, we cannot deny at once the action of a smaller companion in a close binary system.

In the following we will point out the significance of the correlation between the two magnitudes - the effective magnetic field strength B_e and the radial velocity RV - for the explanation of the kinematics of the special stellar system of 52 Her, giving an overlook of the observational material available up to 1989. Arguing and proving systematically all significant facts we will point at the main features concluding on a precessional model.

Correspondence to: ewald-gerth@t-online.de

⋆ This paper is an actualized version of a contribution to a colloquium in Potsdam-Babelsberg 20.-25.Nov.1989, which was printed as a manuscript in $Mitteilungen\ des\ Karl-Schwarzschild-Observatoriums\ Tautenburg$ Nr. 125, p. 33-42. The text has been arranged for $Astronomische\ Nachrichten$, but for the time being it will be used only in the homepage www.ewald-gerth.de.

⋆⋆ Most of the observations were carried out at the 2m telescope in Tautenburg. The reductions were performed at the Astrophysical Observatory Potsdam, which belonged up to 1992 to the Central Institute of Astrophysics of the Academy of Sciences of the GDR.

Precession is a rare case in astrophysics. It occurs in close binary systems with declined rotation and revolution axes and can be revealed only in long secular observation periods.

2. Observational foundation

2.1. Results of other authors

Besides BABCOCK's two measurements quoted above a great share to the investigation of the magnetic field of 52 Her took WOLFF and PRESTON [1978] with 37 spectrograms from the Lick Observatory (1963-1968) and 10 spectrograms from Mauna Kea (1971). All plates show only a positive polarity of the magnetic field, but the mean values differ significantly between that ones from Lick (about +1500 Gauss) and those ones from Mauna Kea (about +750 Gauss).

After the author's opinion this difference could not be explained merely by systematic instrumental deviations as a measuring artifact, but there should be considered the possibility of secular variations. All measurements show a short-time variation with a period of 3.8575 d being attributed to the rotation of the star; the amplitude, however, is of the order of 150 Gauss for the Lick data and 300 Gauss for the Mauna Kea data. The radial velocities were determined from all plates averaging to RV -(0.2+0.5) km/s, but no phase-dependent variation could be detected. Unfortunately, there were not committed any RV data with respect to single plates. In this regard we refer to the authors for the plates being not at our disposal. BORRA and LANDSTREET [1980] published 6 photoelectrically determined measuring data of the magnetic field strength showing also a monotonically positive polarity, not accounting for the radial velocity.

2.2. Report on our own measuring results

Our own measurements started in 1974, when the Modified Abbe-comparator was ready to work [1977]. In 1976 a first report on the measurement of 21 Zeeman-plates of 52 Her was given on the IId Conference of Magnetic Stars in Shemakha (not published). Further reports followed 1978 in Prague (IIIrd Conf.) and 1980 in Zelenchuk (IVth Conf.). Especially the last mentioned report [1981] based on 36 Zeeman-spectrograms obtained up to 1976 from Tautenburg corroborated the findings of WOLFF and PRFSTON [1970] concerning the short-time variation caused (presumably) by the rotation of the star. But also the long-time (secular) variation could be established. It could be shown moreover, that the radial velocity varies with the same (rotational) period as the magnetic field strength does but doing so with a long-time variation of the amplitude. At that time the last measurements of the years 1977 to 1979, which showed surprisingly a reversal of the magnetic polarity, were not taken into account for being suspected to be ill-measured. There were good reasons to call in doubt the reliability of the optical observing instrumentation as the whole as well as crucial parts of the equipment. Maybe the Zeeman-analyzer could have been not well adjusted. Indeed, the 5 inclined metallic reflections of the light beam from the main mirror to the Coudé-spectrograph produce a considerable instrumental polarization that has to be governed by a painstaking adjustment of a compensator. Later on, after having reassured all technical conditions during the observations and having compared the measurements with that ones of other well investigated stars (especially 53 Cam), the measurements proved correct. So we do take now the reversal of the magnetic polarity true and wait for a reoccurrence of this unexpected phenomenon. However, because of all the uncertainties coming up during the revision of equipment and methods, for the time being the measuring data were held back and, therefore, have not been published yet.

In the meantime the observational campaign for collecting spectrograms of 52 Her continued. Since 1982 we achieved plates not only from Tautenburg but also from Zelenchuk (USSR) and Rozhen (Bulgaria). This contribution led to a very useful completion of the collection of plates but it is, furthermore, an important way to compare the results of different observatories to get rid of peculiar instrumental influences.

Summarizing the observational material serving for the determination of the magnetic field strength as well as the radial velocity, we have at our disposal now 187 Zeeman-spectrograms. assorted in the following table, pointing to the observatory, the names of the main observers, span of time, number and sort of spectrograms, dispersion, and references.

1. $Observations\ in\ Tautenburg$:
Bartl 1971: 18 Cassegrain spectrograms (10 Å/mm)
Bartl 1973-1978: 36 Coudé-spectrograms (7.9 Å/mm) Ref.: Gerth,E. : Report on the IV Conference in Zelenchuk [1980]
Häupl, Lehmann, Woche 1978-1988: 83 Coudé-spectrograms (7.9 Å/mm)
Ref.: Gerth,E.: Report on all measurements (B and RV) from Tautenburg up to 1989. Astronomische Nachrichten [1990]

2. $Observations\ in\ Zelenchuk$:
Glagolevskij. Romanyuk. Bychkov: 1981-1988 43 Codé-spectrograms (9.15 Å/mm)

3. $Observations\ in\ Rozhen$:
Kolev. Tomov. Ilijev 1984-1986: 7 Codé-spectrograms (9 Å/mm)

Not all of the Zeeman-plates were suited for determining the magnetic field strength as well as the radial velocity. In some cases the comparison spectrum was defect or shifted off for being not taken simultaneously with the stellar spectrum. The plates from Zelenchuk show a systematical shift of RV by +3km/s superposed by a scatter of the same order, so that we relate only to the very reliable magnetic values of these plates.

On the other hand, there are plates that allow only to derive reliably the radial velocity. So 1976 in Tautenburg the Zeeman-analyzer was ill-adjusted resulting in no Zeeman-displacement on the plates. Furthermore, some plates were taken without any Zeeman-analyzer.

Besides of this, some normal plates with spectra of 52 Her were available. By courtesy of the colleagues of the Astronomical Institute of UMK Toruń we could measure additionally 17 plates (8.5 Å/mm) from the Dominion Observatory in Victoria and 4 plates (9.5 Å/mm, 12.7 Å/mm) from

Haute-Provence. Altogether we used 203 plates to determine the radial velocity.

3. Time-dependence of the magnetic field

3.1. Long-periodical variations

Putting all values of the magnetic field strength available up to now together on one progressive time-scale then we establish a predominantly positive effective magnetic field at the star, see Fig 1.

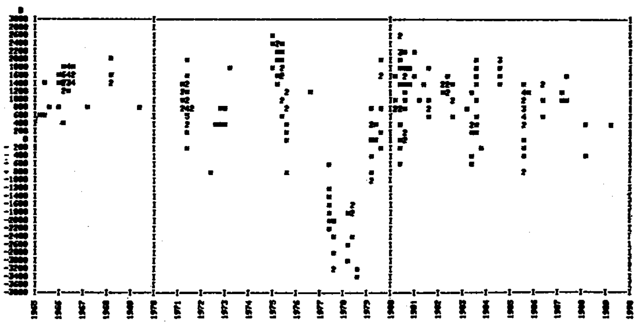

Fig. 1 Time-progression diagram of the magnetic field data from 1965 to 1990 with a conspicuous negative peak in 1978
(The figures in this paper are taken from [GERTH, 1990] and should not be assessed for modern graphics quality. They demonstrate as originals the pseudo-graphical representation and documentation of results in the 80ties by use of an automatic typewriter.)

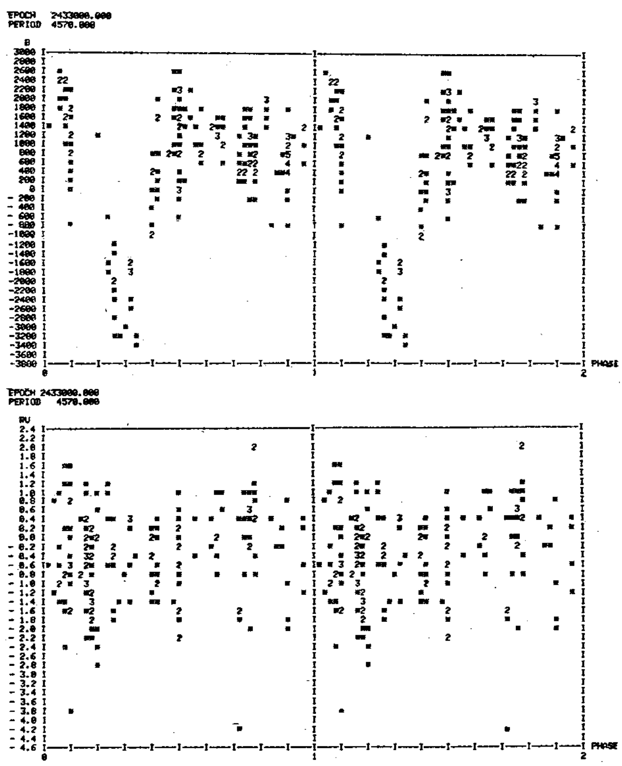

Fig.2. Phase-correlated diagrams of the magnetic data (a) and the radial velocity data (b) with the period of about 12.5 a (4570 d).

Not accounting for the scatter the reversal of polarity in the years 1977-1978 seems unique. Regardless of the conviction that any last decision whether or not the reversal was real can be made only after future observations showing the repetition of this effect, an unambiguous trend of secular variation is already recognizable. This becomes more obvious by means of a search for periods carried out with a program using the Fourier transformation, which brings about that the maximal power occurs at periods of 8.02 a and 19.4 a. The arrangement of dots, however, would fit best with an estimated period of 12.5 a. Since the measuring data cover only a time interval of the order of one period, anyway a final value of the period cannot be given yet.

In Fig. 2a the magnetic data are represented in a phase diagram with the period of 12.5 a.

3.2. Short-periodical variations

Searching for periods in the region of days we can corroborate the rotational period of 3.8575 d found by PRESTON and WOLFF [1978] (Fig. 3a) on the basis of our data to 3.8564 d (Fig 3b). If we investigate single annual groups of either the magnetic or the radial velocity data, then the period seems to vary, indicating a slight frequency modulation. Besides of this the amplitude and the phase change their magnitudes. Regions of large magnitudes coincide with broad scatter as being in the years 1971, 1975, 1980, 1984, and 1988; on the other hand, regions of small magnitudes do with low scatter as being in the years 1978 and 1982. The amplitude of the short-periodic variation is much lower than that of the long periodic variation; therefore, it makes no sense to demonstrate the short-periodic magnetic variation in a phase diagram.

4. Time-dependence of the radial velocity

4.1. Long-periodical variations

Arranging all radial velocity data in a time-progression diagram we see at the ribbon of straying dots narrow parts that remind of the knots in a beating oscillation. We have arranged the data in a phase diagram by the period of 12.5 a (see Fig. 2b) together with the magnetic data that later we do account for. Despite the long-periodic variation of the straying width, however, there is obviously no sign of any secular variation of the mean magnitude of the radial velocity.

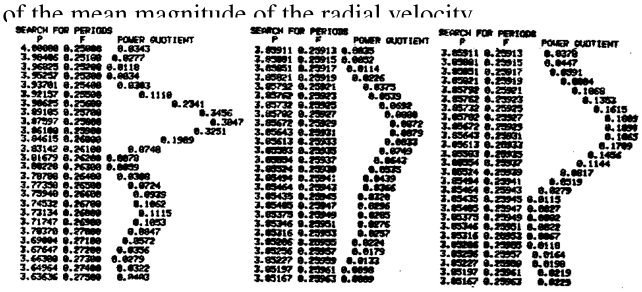

Fig. 3. Periodograms in the freqency region of the rotational period
a) Magnetic data of WOLFF and PRESTON [1978]
b) Magnetic data of Tautenburg, Zelenchuk, Rozhen
c) Radial velocity data of Tautenburg (and Dominion Obs. Victoria)

Our own data are founded on a much broader time base and, therefore, should be assessed to give the more accurate value of the rotational period as being determined up to now.

4.2. Short-time variations

By searching for periods on the radial velocity data using the homogeneous set of the observations from Tautenburg we get a conspicuous power maximum at a period of 3.85646 d (see Fig. 3c) in full agreement with the magnetic data, confirming thus the coordination of the radial velocity variation to the rotation of the star (Fig. 4).

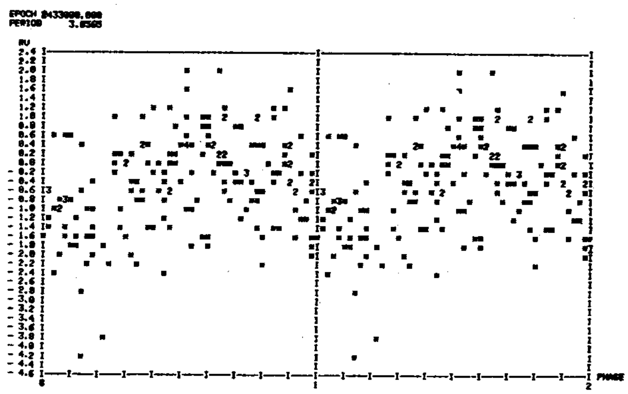

Fig.4. Phase diagram of the radial velocity measurements using the period p=3.85646 d that emerges by a search for periods. PRESTON and WOLFF [1978] derived by their data p=3.8575 d.

Because of the absence of any secular variation of the radial velocity the straying ribbon is confined to a minimum so that the rotational wave becomes evident.

The wave shows a relatively steep ascending and a slower descending part of the curvature. This could suggest an orbital motion, possibly synchronized with the rotation. But looking closer to the form of the maximum in the power spectrum one can perceive a split-up, being the result of a superposition of two oscillations with narrow frequencies. In the power spectrum the two peaks can be equal only if there is an equilibrium of values in each bulge of the beat, departed by a knot. This becomes very evident, if we use only the data of the annual groups of 1976 (48 values) and 1979/1980 (34 values), see Fig. 5. The half distance between the peaks amounts to a frequency difference of 0.00034 l/d, which corresponds to a beating period of approximately 8 years, respectively, to a double wave of 16 years.

All these findings agree well with the assumption that an oscillation with a period of nearly 4 days is modulated by another oscillation covering maybe 16 years.

5. Phase relations between the variations of Be and RV

5.1. Short-periodic variation

The Fourier analysis of all data yields in the vicinity of the "rotational period" of 3.8575 d after PRESTON and WOLFF [1978] for the radial velocity the value 3.856524 d and for the magnetic field the value 3.856401 d. Taking the average by 3.85646 d we find, using the algorithm of the program, the phase of the radial velocity wave of -0.18965 and for the magnetic field wave the phase 0.03507.

P	F	POWER QUOTIENT
3.87297	0.2582	0.0022
3.87147	0.2583	0.0010
3.86997	0.2584	0.0187
3.86847	0.2585	0.0233
3.86698	0.2586	0.0854
3.86548	0.2587	0.0652
3.86399	0.2588	0.0337
3.86250	0.2589	0.0317
3.86100	0.2590	0.0736
3.85951	0.2591	0.1376
3.85802	0.2592	0.1725
3.85654	0.2593	0.1378
3.85654	0.2594	0.0578
3.85356	0.2595	0.0065
3.85208	0.2596	0.0087
3.85060	0.2597	0.0183

Fig. 5 Part of the power spectrum in the region of the proposed rotational period using the radial velocity data of the annual groups 1976 and 1979/1900. The split-up amounts to a frequency difference of 0.00068 1/d. According to the well-known modulation formula, which regards the sum and the difference of two frequencies, the reciprocal of half of this value is the beating period. The unequal heights of the peaks stand for the different quantities of data belonging to each bulge.

This means that the magnetic field succeeds after the radial velocity by the phase difference 0.22474 or by the angle of 80.9 degr. In the limits of the measuring accuracy this may be regarded as nearly the right angle, which reflects a quarter turn of the rotation. If the rotation model is right, then, looking at the positive magnetic pole, the radial velocity has its crossover because of the perpendicular motion of the pole to the line of sight; thereby it comes from the negative region (approaching) and goes over into the positive region (removing).

Also these findings agree well with the rotational motion of the star proposed by WOLFF and PRESTON, if the velocity variation is correlated with the inhomogeneity of the radiating stellar atmosphere caused by the distribution of the magnetic field that penetrates the star's surface.

5.2. Long-periodic variations

A remarkable phase relation exists between the narrow parts of the straying ribbon of the radial velocity values and the extrema of the magnetic field strength, which we tentatively attribute to the knots of a beat. The very conspicuous knot in the ribbon of the RV dots in 1978 falls just into the time of the negative extremum of the magnetic field strength. A second knot seems to coincide with the dip of the magnetic curve on the positive plateau. The bulges of the "beat" occur in every case in times of maximal field strength of positive polarity. In Fig. 2 the variations of the magnetic field strength and the radial velocity are arranged in phase by the same period of 4570 d. The "beat" in Fig. 2b may be assessed to be caused by random straying. However, if we take the half period of 2285 d, then two neighboring bulges wi1l be superposed, making the knots very conspicuous, see Fig. 6.

This brings about that radial velocity and magnetic field are strongly correlated in the course of time. Long-time and short-time variations are mixed by some kind of modulation. The correct analysis would be decisive for the construction of any model of the star.

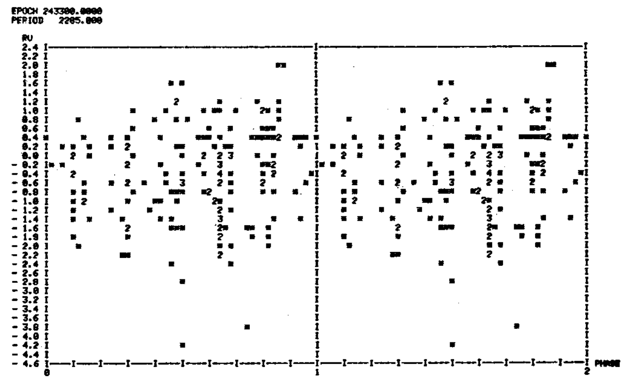

Fig.6. Phase diagram of the radial velocity data by a period of p = 2285 d, which suggests a beat with bulges and knots.

We try to demonstrate the phase relations between the magnetic and radial velocity variations by a sketched phase diagram in Fig. 7.

6. The cause of modulation - a kinematic effect?

Supposing a modulation phenomenon at the star 52 Her we rely only on the radial velocity data being sufficiently homogeneously spread over the entire beating period, which is, unfortunately, not fulfilled in the case of the magnetic data. In particular, the failure of the magnetic data of the year 1976 should be taken seriously because of the loss of information about the expected bulge of the beat, rendering any deduction of the modulation out of the data indifferent. The validity of the modulation for the magnetic data can, therefore, only be verified indirectly by synthetic construction of the variation, showing, that there is no main contradiction to the really observed magnitudes. However, if the alleged modulation indeed takes place, we have to ask for the cause and the conditions that lead to the effect eliciting by analysis of the radial velocity data.

First let us consider the kind of modulation we come upon. There is no evidence for an amplitude modulation as known e.g. from broadcasting transmission, which shows a carrier frequency and two side bands, but we are concerned with a simple multiplication of a carrier oscillation with a long-periodic sinusoidal function. By this way as positive as negative parts of the modulating function come into action, which leads to a phase reversal between two neighboring bulges of the beat. This can be corroborated within the error limits by the measuring data.

Searching for the reason of the modulation, let us first consider the proposal made by WOLFF and PRESTON [1978] for a kinematic cause of the magnetic variation, namely the rotation of the star. The variation of both RV and B might be caused by the inhomogeneous surface distribution of the moving and radiating parts (spots) of the rotating star facing differently to the observer. The phase reversal, however, cannot be explained simply by means of the arrangement of spots on the surface or by a filtering effect of the varying surface transmittancy.

Taking into account the sign-changing effect of a varying aspect angle, we come to a plausible explanation of the modulation type: When we look at the rotation pole we cannot see any variation representing the knot of the beat. Swinging over the pole from one side to the other gives the crossover between two bulges of the beat with opposite phases of the oscillation. In this view the kinetics is not confined to the rotation alone but extended to the change of the direction of the rotational axis!

The modulation becomes still more reasonable if we suppose that the magnetic and the rotational axes include between them an angle according to the oblique rotator model, which, as showed by WOLFF and PRESTON [1978. p. 4O9], amounts only to the limiting value of 26^o, i.e. the axes being nearly parallel. Thus, the rotational and the magnetic poles approximately fall together, so that the knots of the beat of the radial velocity coincide with the extrema of the magnetic field strength.

Nevertheless, there is an appreciable angle between the axes, which produces an undulation of the effective magnetic field strength if the star is not seen (rotation-)pole-on but more or less inclinedly to the rotational axis. The maximal undulation is given, obviously, when the inclination of the rotational axis to the line of sight has its largest extension. Changing the aspect angle, two such maxima of the undulation occur within a period leaving between them a minimum, which might be the dip in the straying ribbon in Fig. 2a.

If this idea of a kinematic cause for the modulation is true, then both the radial velocity and the magnetic field strength are intermodulated by a period of about 4 days and a period of about 15 years. The short period can easily be attributed to the rotation of the star as having already done, however, what might be the long period we have further to ask for. Therefore, the investigation of the modulation is most important for any conclusive explanation of the star's behavior.

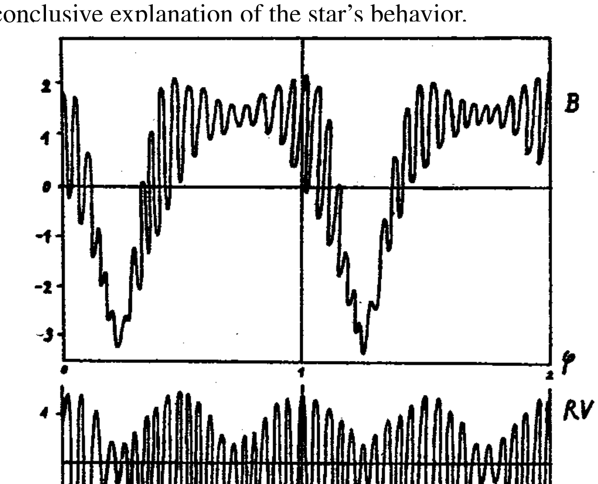

Fig. 7. Correlated phase diagrams of the beats of the magnetic field strength (a) and the radial velocity (b) on the assumption of the validity of intermodulation (sketched with arbitrary parameters).

In Fig. 7 we demonstrate, using arbitrary parameters. the correlated beating oscillations of the radial velocity and the magnetic field strength as we could expect at the star 52 Her on assumptions proposed above.

7. Independent evidences

Suppose the rotational axis changed indeed its direction in space, then we have to draw the conclusion that there takes place an interaction of at least two bodies, the consequences of which we will discuss below. However, because a changing aspect angle could hardly be taken for granted we should seek for other independent evidences making such a challenging assertion more reasonable.

Usually, the equatorial velocity v of a star is determined by the DOPPLER broadening of a line profile, leaving the magnitude of the aspect angle i open. Only the combined form $v\sin(i)$ is known as a typical (i.e. constant) parameter of any star, not accounting for the change of i. The real stellar constant is, of course, for a long time the equatorial velocity v. So we conclude, that a variation of $v\sin(i)$ has to be traced back, consequently, to a variation of i. Thereby we have to take into account that the magnetic field itself produces a line broadening, the amount of which is known knowing the magnetic field strength. However, in connection with the phase relation to the modulation the kinetic foundation of the variation of i is beyond question.

Indeed, the variation of $v\sin(i)$ at a lot of spectrograms of 52 Her, which we used for our RV and B measurements, could be established significantly by LEHMANN [1988. p. 90]. Of decisive importance is the fact that the minima of $v\sin(i)$ coincide with the knots of the beat of the radial velocity as well as with the negative extremum in 1978 and the dip in 1983 of the effective magnetic field strength. If we made responsible for the line broadening the magnetic intensification, then we should have the maximal line widths at the times when we look at the magnetic poles, but we find in fact the reverse relation, supporting thus strongly the kinematic foundation of the observed phenomena. LEHMANN [1986, 1987, 1988] considered as the most probable cause for the variation of i at the Star 52 Her a *precessional motion*.

8. The precessional model of the star 52 Her

On grounds of the observational material known up to 1980 [1981, p. 31] the first proposal of an explanation of the secular variation of the effective magnetic field strength by a precession model as an alternative of the hitherto commonly adopted dynamo model (KRAUSE and RÄDLER [1980]) was made by GERTH [1981. p. 32]. Later on this idea of a kinematic cause of the secular variation of the observed magnetic field strength has been vehemently discussed and called in question by the supporters of the dynamo theory particularly because of some hard physical conditions raised by assuming precession. We will not refresh this discussion here. An attempt to give a reasonable physical foundation for the quantitative relations among the periods of

1. rotation of the main star,
2. evolution of the companion, and
3. precession

as well as for the accompanied masses and their spatial distributions has been made by GERTH [1984]. LEHMANN [1986] has investigated this problem more detailedly in his doctor thesis. Indubitably, the last word might speak only nature itself, recognized by ourselves as observers. Leaving aside, however, all the problems connected with the correct theoretical derivation (founded mainly on celestial mechanics and hydrodynamics), we may construct a precessional model of the star 52 Her, which makes us the observed phenomena plausible. Let us consider such a model!

52 Her is known as a visible triple system. Why should there not exist further bodies in the close neighborhood of the main star? Supposing, a nearby companion is orbiting around the main component, the rotational axis of which being inclined to the orbital plane, then the companion causes a torque momentum in the rotationally flattened star body, conducting to an interactional precession of the main star itself and the orbital plane.

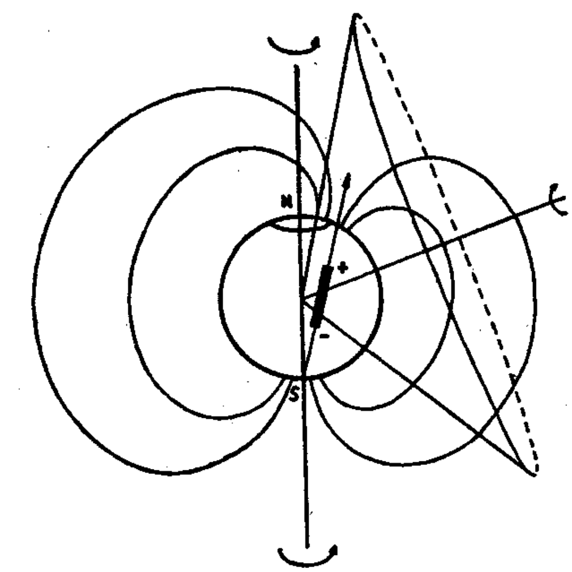

Fig. 8. Demonstration of the precessional model of the star 52 Her. The decentered oblique dipole (rectangle), making the surrounding field asymmetrical, (lines), points to the magnetic north pole, describing a circle around the figure axis. In this representation the line of sight precesses around the precessional axis on a cone.

If the magnetic dipole axis is bound to the figure axis of the rotating star, then the magnetic curve reflects the precessional motion. In the case of a parallel arrangement of both the magnetic and the rotational axes the magnetic curve would be a sinusoidal one. However, with an angle between the two axes as being the case for the oblique rotator the magnetic field strength performs undulations when the star is seen more or less across its rotational axis because of the rotating magnetic pole. Looking at the star (rotation-)pole-on, the undulations disappear marking a dip in the magnetic curve, which is fulfilled indeed at the rotational northern pole. The sharp negative extremum in the magnetic curve does not show any dip. Therefore, we may conclude that the negative magnetic pole and the rotational southern pole nearly coincide. So we have an oblique rotator with a decentered magnetic dipole, which points with its negative end to the south pole and pierces with the elongation of its positive tip through the northern hemisphere in some distance from the north pole. The figure axis describes a cone around the precessional axis with a spatial angle opened to more than 90^o so that both poles, alternatively, may partly be looked on in one precessional period. The precessional axis represents the angular momentum of the whole kinematic system and is, therefore, in regard of its direction as an axial vector fixed in space.

In Fig. 7 we attempt to demonstrate the precessional model of 52 Her as we see it on the base of knowledge hitherto gained in a very rough manner, knowing that this picture can be changed either by more accurate evaluation of the up to now available observational material or/and by new observations.

9. Conclusion - a decade later

Precession of stellar binary systems is a secular phenomenon comparably with the orbital motion of visual binaries and demands for its revelation very long times filled with observations. In the case of 52 Her a time span of 15 years is covered with measurements of the magnetic field strength and the radial velocity by equal instrumental and evaluational conditions and processing, rendering a very homogeneous row of basic data for the search of periods and concluding on appropriate models of the stellar system. If the secular period is not completely run through, then a preliminary period by the method of ”truncated waves” analysis gives a forecast of the entire period, which can be corroborated and improved by further continued observations. Special features - so as the conspicuous negative peak of the magnetic field strength in 1978 - should reoccur anytime later and would confirm the assumptions made on the poor data basis of only part of the period. By the forecast of 16 years the repetition of the peak could be expected in 1994 or later on - .

Unfortunately, the observations of the magnetic behavior of 52 Her have been broken off in 1992 because of thematic and personal changes after the closure of the Central Institute of Astrophysics of the GDR and its reestablishment as the Astrophysical Institute Potsdam and the Thüringer Landessternwarte Tautenburg. Thus, the observation of 52 Her remains ”truncated”. However, the researching program including the observation of the magnetic field of 52 Her has been continued for some years at the 6m telescope in Nizhnyj Arkhyz of the Special Astrophysical Observatory of the Russian Academy of Sciences. A series of photographic Coudé-spectrograms using the Zeeman-analyzer has been obtained by Glagolevskij and coworkers. The plates have been measured and reduced by the author using the method applied equally to the plates from Tautenburg. Then also at SAO in Nizhnij Arkhys the observation method was changed to a photoelectric one. The result of the observations at SAO was, that the magnetic field of 52 Her remained positive up to the year 1993. A renewed period analysis (report foreseen in a separate paper) by the method of the ”truncated waves” seems to prolong the secular period from 16 a to 23.5 a, so that we could expect the reoccurrence of the negative peak in the millenium year 2000. Alas, there are no more observations.

Acknowledgements. With gratitude the author is to commemorate the experienced astronomer E. BARTL (1921-1985), who carried out most of the observations. For further observations the author is indebted to Dr. F. BÖRNGEN, Dr. R. ZIENER, Dr. H. LEHMANN, W. HÄUPL. Thanks also to Dr. Yu.V. GLAGOLEVSIJ and his coworkers I.I. Romanyuk and D.M. BYCHKOV of SAO in Nizhnij Arkhyz as well as to Dr. D. KOLEV of the National Observatory Bulgaria in Rozhen for cooperative observation together with the author. The author thanks too Dr. A. BURNICKI (UMK Toruń) for making available a sample of plates from other observatories.
The painstaking work of controlling the instrumental polarization and the comparison with measurements of other stars with known polarity in order to secure the polarity reversal of 52 Her in 1978 have done Prof. Dr. L. OETKEN and Dr. G. SCHOLZ, which deserves special sincere thanks. Last not least the author expresses his indebtedness to the Central Institute of Astrophysics of the GDR, where he has worked in the staff for the secular period of 25 years - enabling him to look for the secular magnetic variations of the remarkable star 52 Her.

References

Babcock, H.W.: 1958. Astrophys. J. Suppl. 3. 141.
Borra. E.F., Landstreet, J.D.: 1980, Astrophys. J. 42, 421.
Gerth. E., Hubrig, H.-J., Oetken, L., Scholz, G.. Strohbusch, H., Czeschka, J.: 1977. Jena Rev. 2, 87.
Gerth, E.: 1978, Magnetic Stars (lIIrd Conference). Ed. J. Grygar and Z. Mikulasek, Prague CSSR. p. 9
Gerth, E.: 1981, Magnetic Stars (IVth Conference). Ed. V. E. Karachentsev, Zelenchuk USSR. p. 31
Gerth, E.: 1984, Astron. Nachr. 305, 329.
Gerth, E.: 1990, Astron. Nachr. 311, 41.
Gerth, E.: 1990, Contr. of the Karl-Schwarzschild-Observatory Tautenburg No 125, p. 33
Krause, P., Rädler, K.-H.: Mean-Field Magneto-Hydrodynamics and Dynamo Theory. 1980, Akademie-Verlag Berlin
Lehmann, H.: 1986, Dissertation: Precession as a possible cause of long periodical variations of the magnetic field.
Lehmann. H.: 1987, Astron. Nachr. 308. 333.
Lehmann. H.: 1988, Magnetic Stars (VIIth Conference). Ed. Yu. V. Glagolevskij and J.M. Kopylov, p. 89-94.
Wolff, S.C., Preston. G.W.: 1978, Pupl. Astron. Soc. Pacific 90. 406.