Polarimetry of Binary Stars

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Abstract. Astronomical polarimetry is a powerful technique that can provide physical information sometimes difficult or impossible to obtain by any other type of observation. Almost every class of binary star can benefit from polarimetric observations: pre-main-sequence objects, close or contact binaries, mass-transfer systems, evolved binaries, cataclysmic variables, eclipsing binaries, etc. In these systems, polarimetry can help determine the geometry of the circumstellar or circumbinary matter distribution, yield information on asymmetries and anisotropies, identify obscured sources, map starspots, detect magnetic fields, and establish orbital parameters, to name just a few examples. The orbital inclination in particular is a very important piece of information for a binary system because it can lead to the determination of the components’ masses, the fundamental parameter that determines a star’s initial structure and subsequent evolution. This review will illustrate the usefulness of polarimetric techniques for the study of binary stars, with examples of results obtained for a variety of binary systems, and an overview of models, including those used to retrieve the orbital inclination.

1. Introduction

This review on polarimetry of binary stars has two main goals. First, to demonstrate and illustrate the usefulness of polarimetry for the study of binary stars, through various examples. As these examples will show, there is quite an interesting variety of information that can be gathered on binaries found all over the HR diagram. The second goal is to present some of the models used to reproduce the observations and extract information such as the orbital inclination. The sets of light curves produced by these models help the interpretation of variations seen in polarimetric observations.

2. Polarization in Binary Stars

The polarization of light observed in binary stars is not due to the binarity itself but is produced by very general phenomena also seen in single stars (and also in non-stellar objects): polarization by scattering and by magnetic fields. What the binarity can potentially introduce is variability of the polarization signal with time. Otherwise, the polarization produced in binaries generally follows well-known basic rules.

In the case of scattering (single or multiple), the strength of the polarized signal will depend on the nature of the scatterers (electrons, molecules, dust
grains), their characteristics (for dust grains, composition and size), and their
distribution (envelope, disk, wind, stream, etc.). In the case of polarization
produced by magnetic fields, the signal will depend on the strength and orientation
of the field. In all cases, polarization also depends on the viewing angle. This
dependence on many and various parameters can be used to extract information
on the nature of scatterers, their spatial distribution, the geometry of a system,
magnetic field characteristics, orbital parameters, etc.

Because of symmetry, one spherical perfect star (perfect in the sense that
it has no spots, for example) does not produce polarization. In 1946, Chand-
rasekhar predicted that the limb of a star is polarized at about 12%, in the
best case of a pure electron scattering atmosphere. But if the star is spherical
(symmetric) the integrated polarization is zero. In a similar way, a spherical
distribution of scatterers will not produce polarization when the light is inte-
grated over the whole distribution. To produce polarization, one has to break
this symmetry.

For example, the surface of a spherical star can be deformed by rotation. For
binaries, tidal distortion will produce a similar effect. In eclipsing binaries, the
eclipse can reveal the limb polarization, a phenomenon called the Chandrasekhar
effect. For envelopes, any non-spherical distribution can produce polarization:
streams, disks, aspherical winds, or spherical distributions with inhomogeneities,
etc.

Almost any type of binary can produce observable polarization. Pre-main-
sequence stars have disks and envelopes where scattering and polarization occur.
Main sequence stars may have shells and winds, and produce polarization in
a similar way. Eclipsing binaries can exhibit the Chandrasekhar effect. Cata-
clysmic variables and other mass-transfer systems have streams of matter flowing
from one star to the other, with possibly accretion disks. Contact binaries can
have non-spherical surfaces. Mass-loss systems such as Wolf-Rayet binaries can
have aspherical winds. Envelopes can be spherical but present inhomogeneities
and unusual structures that will produce a net polarization.

3. Removal of the Interstellar Polarization

In general, the observed polarization of any object is the sum of intrinsic po-
larization produced at the source or in its immediate vicinity, and interstellar
(and sometimes intra-cluster) polarization produced in the interstellar medium
by grains located in the line of sight. If the information sought is contained in
the intrinsic degree of polarization, the interstellar (IS) polarization has to first
be removed from the observations. There are two general methods to do this.

One can use stellar polarization catalogs to estimate the strength and ori-
entation of the IS polarization in the vicinity of the target. Compilations such
as those of [Mathewson et al. 1978] and [Heiles 2000] are used to find the
polarization of neighboring stars within a certain angular distance of the target
and, since the IS polarization also depends on distance, at a similar distance.
The averaged polarization is assumed to describes the IS polarization for the
target and subtracted. The remaining polarization is only an estimate of the
intrinsic polarization. If the IS polarization in a region of the sky is strong and
uniform, its estimation will be easier to make and more reliable. But if the IS
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Polarization is weak or not very well organized, the estimate will more uncertain, which will make the estimate of the intrinsic polarization uncertain too.

One can also use Serkowski’s law for the IS polarization (Serkowski, Mathewson, & Ford 1978), assume that anything bell-shaped in the polarization as a function of wavelength is of IS origin, and subtract it. Neither of these method is perfect, though, and one should not over-interpret the resulting calculated intrinsic polarization. For examples of IS polarization subtraction, see Manset & Bastien (2001b) or Hoffman, Nordsieck, & Fox (1998).

4. Some of the 101 Uses of Polarimetry for the Study of Binary Stars

4.1. Polarimetry as a Tool to Discover Binaries

Polarimetry can be used to discover binary stars, like in the serendipitous discovery made by Gledhill et al. (2001). The goal of their project was to detect and image the dusty circumstellar (CS) envelopes around protoplanetary nebulae using NIR polarimetric imaging. This technique successfully separates the scattered light coming from the faint envelope from the glare of the central object. As it can easily be seen in the figures from that paper, the faint nebula is not seen in the total flux images, whereas the polarized flux maps clearly show the fainter nebulosity structures.

The polarized flux contours usually reveal structures such as bipolar nebulae, ellipsoidal envelopes, shells, and rings. But in one case (IRAS 19475+3119) out of the 15 where a CS envelope was detected, spiral arms are clearly seen. This is interpreted as being the signature of an previously undetected binary star companion interacting with the primary object. So in this first example, polarimetry has revealed the presence of a binary star.

4.2. Polarimetry as a Probe of the Circumstellar or Circumbinary Environment

When a binary (or a single star) is known or even just suspected of having a disk or envelope, imaging polarimetry can be used to retrieve information on the envelope itself or on its scatterers. For example, Potter et al. (2000) have obtained adaptive-optics, high-resolution imaging polarimetry at 1.2 $\mu$m of the circumbinary (CB) disk around UY Aur. The polarimetric observations show a centrosymmetric pattern that is compared to a Mie scattering model. This analysis suggests that the polarization comes mostly from the smallest grains present in the disk ($\sim 0.03\mu$m) and that the optical and IR light comes from a large flattened disk. Indeed, a spherical distribution of scatterers does not show changes in the the degree of polarization measured as a function of position angle in the envelope. UY Aur presents a sinusoidal-like change in polarization as a function of position angle, with maxima at the two 90° scattering angles, the distinguishing polarization signature of a disk.

A radial increase in polarization, of 10% per arcsec, is also observed, but it is unknown for now if it is a physical effect (multiple scattering events) or an instrumental artefact (contamination from the unpolarized PSF).

Another CB disk studied in a similar way is GG Tau (Silber et al. 2000; Duchêne et al. 2001). Also see these proceedings for Fukagawa et al.’s contri-
bution for the binary LkHa 198. The large scale vector pattern in this system is approximately centrosymmetric around the primary star, indicating that the major illuminating source in this region is the primary, not the companion star.

Other high-resolution, high-contrast IR observations of the CS environment of (single) young stars were presented by Potter (these proceedings) and can be used to get the physical parameters of the disks such as the radial extent and inclination. Also of interest to this subject are the reviews by Ménard and by Tamura & Fukagawa (these proceedings).

Finally, spectropolarimetry can also be used to determine the geometry and temperature structure of circumstellar disks (see Bjorkman, Bjorkman, & Carciofi; Oudmaijer; Vink et al., these proceedings).

4.3. Polarimetry to Get Insight into Star Formation Processes

Polarimetry can be used to study individual binaries, or a type of binaries as a group, and even to get insight into physical processes, for example, star formation processes.

Fragmentation (as in fragmentation of a cloud core or as in growth of an instability at the outer edge of a disk) is now the best star formation scenario. Fragmentation of cores in a cloud can create binaries with non-coplanar orbits, but if stars grow from instabilities in the outer parts of a disk, systems with parallel rotation axes will result.

To discriminate between the two scenarios, Monin, Ménard, & Duchêne (1998) used polarimetry to estimate the relative orientation of the star plus disk systems in pre-main-sequence wide binaries. Wide binaries were selected so the polarization of each star plus disk could be measured separately. The data consists of linear polarization measurements, with a careful analysis to consider possible biases due to IS polarization. The result is that for the systems where IS polarization does not introduce a bias, 4 systems have parallel axes, and one, GI Tau + GK Tau, clearly does not.

Therefore, the alignment seen is thought to result from the initial binary formation rather than from tidal interaction (which would produce more non-parallel systems). This result was confirmed by Jensen et al. (2004). For 8 out of 9 binary systems located in the Tau-Aur and Sco-Oph star forming regions, the positions angles of each component of a pair are within 30° of one another, whereas the five triplet and quadruple systems appear to have random axis orientation. See also the contribution of Wolf et al. (in these proceedings) who found that disks in binary systems are preferentially aligned.

So in these projects, the polarimetry has allowed conclusions that go far beyond the properties of binary systems but include insight into fundamental physical processes.

4.4. Polarization by Reflection

So far, the examples have dealt with scattering off particles located in the stars’ environment. Scattering can also occur at a star’s surface, as was first evidenced by Rudy & Kemp (1977). The binary µ Herculis is a close binary where the secondary fills its Roche lobe, and where there is spectroscopic evidence for CS matter.
The linear polarization data show low-amplitude second-harmonics variations of 0.06% amplitude in Stokes parameter $Q$. These periodic variations can be caused by the reflection of light off the secondary atmosphere, or by scattering off the stream of gas seen spectroscopically. Modelling discriminates between the two possibilities and favors the reflection mechanism.

There are not many cases of the reflection mechanism in the literature. A more recent example can be found in Berdyugin & Harries (1999) where 0.3-0.4% polarization variations are seen for LZ Cep. In this case, it is thought that the reflection mechanism is clearly the only possible explanation because there is no spectroscopic evidence for CS material, and the variations are too large to be due to tidal deformation. In addition to pinpointing the polarization mechanism, the authors were able to recover the orbital inclination.

4.5. The Chandrasekhar Effect in Eclipsing Binaries

The limb polarization effect, or Chandrasekhar effect, was predicted in 1946, but only observed in 1983\textsuperscript{1} (Kemp et al. 1983). The data used for this discovery consisted in white light observations of Algol taken mostly around primary eclipse. Even though the amplitude of the polarimetric variations are only of the order of 0.01%, primary eclipses clearly present a sharp positive peak with weaker negative lobes in $Q$, and a S-shaped pattern of the $U$ Stokes parameter. The patterns observed are compatible with the Chandrasekhar effect.

The Chandrasekhar effect was studied theoretically five years later by Landi Degl’Innocenti, Landi Degl’Innocenti, & Landolfi (1988) and analytical expressions were derived for the polarization expected during an eclipse due to limb polarization produced in a very thin annulus around the limb. In addition to a thin annulus approximation, this study concerned detached binaries with spherical stars, and no reflection effect. Using the best estimates by Kemp et al. (1983) for the radius and eclipse geometry for Algol, Landi Degl’Innocenti, Landi Degl’Innocenti, & Landolfi (1988) were able to reproduce the general shape of the polarimetric variations during the eclipse.

Another 5 years later, Wilson & Liou (1993) made further improvements with a more general binary star model that includes tidal and rotational distortion, gravity and limb darkening, reflection effect, without the thin ring approximation. The resulting $Q$ and $U$ polarimetric curves show more structures. The scale of the variations, less than 0.01% help explain why this effect had not been observed before.

The eclipsing binary V444 Cyg, composed of a Wolf-Rayet and an O star, was observed by Robert et al. (1990) and shows clear and phased-locked, and good amplitude variations of about 0.3%. The second harmonic information was used to retrieve the orbital parameters, while modeling the eclipse yielded information on the size of the stars.

\textsuperscript{1}In his summary presentation, Roger Hildebrand told an interesting story about this. Chandrasekhar learned almost simultaneously that he had won the Noble prize and that the limb polarization effect had been detected. Apparently, Chandrasekhar was more delighted with the observational proof of his prediction rather than by receiving the Nobel prize!
4.6. Circular Polarization in Binaries

The examples presented so far used linear polarimetry, but binaries with strong magnetic fields, such as cataclysmic variables, present significant levels of circular polarization. See in these proceedings the contribution by Rodrigues et al.

A recent example of circular polarimetry of a polar (a sub-class of cataclysmic variable in which the magnetic field of the white dwarf is so strong that the white dwarf is synchronous with the secondary) can be found in Romero-Colmenero et al. (2003). The linear polarization is relatively stable but the circular polarization can be at times positive or negative. When both signs of circular polarization are observed, the white dwarf is accreting matter on two distinct spots. But spots can be transient, as sometimes the circular polarization only shows one sign. Models are used to recover the orbital inclination and the latitude of the spots on the stellar surface.

Other examples of circular polarization produced by cyclotron emission regions can be found in Schwope & Beuermann (1989), Pirola et al. (1994), Katajainen et al. (2003).

5. Orbital Inclination

5.1. The Basic Models

A few theoretical models describe polarimetric variations of binary systems and can usually be used to find the orbital inclination. Such information is very valuable, since it can lead to the determination of the absolute masses of the stars, the fundamental parameter for a star. With the mass, one can determine the nature of a binary (for e.g., if it has a compact companion or something more massive; see Dolan & Tapia 1989 or Dolan 1992), one can make comparisons with theoretical models of star formation or evolution, study the IMF, etc.

Rudy & Kemp (1978) have shown that in the plane of the Stokes parameters $Q$ and $U$, the polarization as a function of time traces an ellipse, twice per orbit, and the eccentricity of this ellipse depends only on the orbital inclination. The inclination found is independent of size, shape and position of the circumstellar region.

A very similar but more general and more often used method is that of Brown, McLean, & Emslie (1978) (hereafter referred to as BME), who use a first and second-order Fourier analysis of the Stokes curve to find, in addition to the orbital inclination, moment integrals of the distribution.

The BME formalism includes the following assumptions:

- the binary star is in a circular orbit
- the stars are point-like
- photometric variability, if any, is low
- the scatterers are electrons
- the scatterers’ distribution is arbitrary but co-rotating (the electron density is fixed in a coordinate system in which the stars are fixed)
• the material is optically thin so only single scattering is considered

Observations are represented as first and second harmonics of \( \lambda = 2\pi \phi \), where \( \phi \) is the orbital phase:

\[
\begin{align*}
Q &= q_0 + q_1 \cos \lambda + q_2 \sin \lambda + q_3 \cos 2\lambda + q_4 \sin 2\lambda, \quad (1) \\
U &= u_0 + u_1 \cos \lambda + u_2 \sin \lambda + u_3 \cos 2\lambda + u_4 \sin 2\lambda. \quad (2)
\end{align*}
\]

This representation is simply a low-order Fourier analysis and is very general. But the coefficients of the fit can be used to get the inclination, using the first (Equation 3) or second (Equation 4) order Fourier coefficients, although it is expected that second order variations will dominate:

\[
\begin{align*}
\left[ \frac{1 - \cos i}{1 + \cos i} \right]^2 &= \frac{(u_1 + q_2)^2 + (u_2 - q_1)^2}{(u_2 + q_1)^2 + (u_1 - q_2)^2}, \quad (3) \\
\left[ \frac{1 - \cos i}{1 + \cos i} \right]^4 &= \frac{(u_3 + q_4)^2 + (u_4 - q_3)^2}{(u_4 + q_3)^2 + (u_3 - q_4)^2}. \quad (4)
\end{align*}
\]

The BME formalism also returns the axis’ orientation on the sky, four integrals of the density distribution, the interstellar \( U \) component and the interstellar \( Q \) component in combination with the fifth integral over the envelope. Although the integrals of the density distribution are also very interesting, their interpretation proves difficult, and the BME formalism is mostly used to recover the orbital inclination and axis orientation on the sky.

### 5.2. Improvements to the BME Formalism

The BME formalism has a specific set of assumptions which are not always adequate to model a target or class of objects. Numerous improvements and extensions to the BME model have been made, some of which will be mentioned here. For additional references and information, the reader is invited to consult the papers mentioned below.

Brown et al. (1982) have relaxed the assumption of corotation implicit in the models developed up until then and studied the polarimetric variations produced by a localized scattering region in an eccentric orbit. Whereas circular orbits only produce second harmonics, eccentric orbits add first and third harmonics. Moreover, erroneous orbital parameters can be found if it is assumed that the orbit is circular when it is in fact eccentric. Simmons & Boyle (1984) made similar studies to apply to the X-ray transient AO 538-66, and also present a correction to equations found in Brown et al. (1982). An eccentric binary model was also used by Robert et al. (1992) to study the Wolf-Rayet (WR) binary EZ CMa, also taking into account the fact that WR envelopes are extended and not localized near one star.

Arbitrary scattering mechanisms (as long as they are spherically symmetric, e.g., Mie scattering on dust grains) were studied by Simmons (1982, 1983), who re-derived the BME equations as a special case.

Fox (1994) has incorporated the finite size of stars in the BME formalism, and found no change to the BME results when there is no occultation of the scatterers, but additional Fourier harmonics when the stars occult the scatterers.
See also [Bastien, 1988] for additional details on the BME model and results for early-type binaries, including the moment integrals over their density distributions.

5.3. Biases and Other Statistical Effects

In their model, [Rudy & Kemp, 1978] use a second-order fit to find the eccentricity of the $QU$ loop, which is related to the orbital inclination $i$. The error on $i$ is then found by the propagation of errors on the regression coefficients. It should be noted that this formal error does not take into account the errors due to incorrect modeling.

[Simmons, Aspin, & Brown, 1980] have shown that taking only the formal error, and ignoring the effects of noise and incorrect modeling can lead to an underestimation of the confidence interval for $i$. So they propose an analytic method for finding confidence intervals that then give the range of $i$ over which the model provides an acceptable fit to the data.

[Aspin, Simmons, & Brown, 1981] have found that the inclination found depends on the real inclination and on the observational errors. They derive the standard deviation necessary, $\sigma_{\text{rec}}$, to determine the inclination to $\approx \pm 5^\circ$, with a 90% confidence level. In practice, these calculations give the lowest possible inclination that can be reliably found according to the quality of the data at hand (number of observations, observational errors, amplitude of the polarimetric variations). This method is useful to ascertain what can be done with the data, but does not actually give, for a given set of observations, a precision on the inclination found by the BME model, nor does it tell if the inclination could still be found to, say, $\pm 10^\circ$, or with a lower significance.

[Simmons, Aspin, & Brown, 1982] have shown that models find inclinations higher than reality, and more so for noisy data or low inclinations.

[Wolinski & Dolan, 1994] have also studied the confidence intervals for orbital parameters determined polarimetrically. They used Monte Carlo simulations to produce synthetic polarimetric curves to which Gaussian noise was added. The result is analyzed with the BME model, and with the use of graphs, one can estimate the confidence intervals for the orbital inclination and other parameters returned by the BME model. With their Fig. 5, one can find, for a given standard deviation over amplitude of the variations ratio, the critical value of inclination below which the $1\sigma$ confidence interval extends to $i = 0^\circ$. This method is again useful to ascertain what can be done with the data. Fig. 4 of that same paper gives, for four levels of data quality, the $1\sigma$ and $2\sigma$ confidence intervals on the inclination found by the BME model. These graphs can be used to read confidence intervals, although interpolation between the curves is necessary to get confidence intervals that go with the quality of the data at hand.

The BME formalism and its various extensions have been successfully used to find the orbital inclination of WR binaries (see for example, [Drissen et al., 1986a, 1986b; Moffat et al., 1990, 1998; Marchenko, Moffat, & Eenens, 1998]), massive interacting binaries [Berdyugin & Tarasov, 1998; Berdyugin, Berdyugina, & Tarasov, 1998], close binaries (e.g. [Luna, 1988]), X-ray binaries, etc.
6. Models

Models of the polarization and polarimetric variations generated in binary stars fall under two broad categories: polarization produced by scattering (mostly linear polarization), and cyclotron emission in star spots (mostly circular polarization). Thomson or Mie single scattering can be readily studied with simple formulas. Multiple scattering requires more complex Monte Carlo simulations.

Modeling can help see what are the effects of a specific geometry, scattering mechanism, eccentric orbits, eclipse geometry, etc. Modeling can be also used to check if the BME formalism to recover the orbital inclination still works for cases initially not considered. A few of those models will be presented here.

6.1. Polarimetry of Pre-Main-Sequence Binary Stars

Observations of pre-main-sequence stars have exploded in the past two decades, and it was only a question of time before somebody would try the BME formalism on T Tauri and Herbig AeBe binaries to get the orbital inclination, masses, and then compare observed masses to theoretical models.

Unfortunately, PMS binaries do not fit the assumptions behind the BME formalism: orbits of short-period spectroscopic binaries are significantly non-circular (up to $e = 0.6$), and the scatterers are dust grains. Manset & Bastien (2000, 2001a) have investigated the effects of Mie scattering and eccentric orbits on polarimetric variations of binary stars and on the inclination found by the BME formalism. The numerical simulations also include pre- and post-scattering extinction factors which were not part of the BME formalism. It is found that orbital eccentricity introduces first harmonic variations, as had been found earlier. Asymmetric scattering functions of dust grains can also introduce first harmonics in the variations. More importantly, the BME equations can be used to get the inclination. For low eccentricities, $e \lesssim 0.3$, the inclinations can be found with the first or second-order coefficients. For the high eccentricities, $0.3 < e < 0.6$, only the first-order coefficients should be used.

Those results were applied to one Herbig AeBe binary (Manset & Bastien 2001b), and about two dozens T Tauri binaries (Manset & Bastien 2002, 2003). The majority of those binaries, 68%, have intrinsic polarization above 0.5% at 7660A. Many of those binaries do not present any evidence other than polarimetric for the presence of dust, indicating that polarimetric techniques are more sensitive to the presence of dust than photometric or spectroscopic ones. A handful of those binaries present interesting periodic and phased-locked variations. Unfortunately, they also exhibit stochastic polarimetric variations that, added to the relatively low-amplitude periodic variations, prevent the BME formalism from getting any sensible inclination.

6.2. Self and Externally Illuminated Disks

Self- and externally illuminated disks around one component of a close detached binary are studied by Hoffman, Whitney, & Nordsieck (2003) with a Monte Carlo radiative transfer code that considers multiple Thomson scattering and variable absorption. In a forthcoming paper (Hoffman, Nordsieck, & Whitney, in preparation), the problem is inverted and it is shown how an analysis of polarimetric observations can provide information on the geometrical and optical
properties of circumstellar matter within a binary system. Thus modelling goes further than obtaining orbital inclination and can give insight into the characteristics of the disks themselves.

6.3. Other Models

Dolan (1984) modeled the polarization produced when the light from a Roche-lobe-filling primary in a close binary scatters off circumstellar matter near the secondary. A regularized Monte Carlo approach allows to include limb and gravity darkening caused by tidal distortion. The resulting polarimetric variations have a morphology in agreement with the theoretical predictions of the BME formalism. The inclination can also be found using the BME equations even if this latter model includes several simplifying assumptions.

Lucas, Fukagawa, & Tamura also describe in these proceedings a 3-dimensional Monte Carlo modelling of HL Tau in the near infrared with aligned nonspherical grains. Infrared linear polarimetry can provide information on the magnetic field, the structure of the system and the grain properties. Circular polarization models show that circular polarization observations can help measure the magnetic field structure in protostars.

A model of the accretion disk around the classical T Tauri star AA Tau was presented by Pinte & Ménard (these proceedings). The quasi cyclic variations of brightness and polarization, with a maximum polarization when the system is faintest, were modeled using eclipses produced by orbiting circumstellar material. The effects on the photometric and polarimetric light curves of a warp at the inner edge of the accretion disk and of hot spots on the stellar surface are studied through multiple scattering Monte-Carlo simulations. The photopolarimetric variations can be explained by the presence of a warp; hot spots have a limited influence on them.

7. Conclusions and Future Work

Almost any type of binary system can benefit from polarimetric observations. If there is scattering material (electrons, molecules, dust grains) in the circumstellar or circumbinary environment, or if magnetic fields are present, polarization of light is possible (if the conditions, such as density of the scatterers or viewing angle, are adequate). Scattering material is present in many binaries, from pre-main-sequence systems to evolved mass transfer binaries, and magnetic fields can be found in cataclysmic variables.

Polarimetry is a very powerful technique that can give information on the geometry of a distribution (spherical envelope or flattened disk, stream, inhomogeneities in a wind, etc.), the characteristics of scatterers (density, nature, temperature, etc.), the location of spots on a star’s surface, and orbital parameters. It can also have a broader application like the study of physical processes such as star formation.

Of high interest for binaries is getting the orbital inclination, since it can lead to the determination of the absolute masses of the stars, which is the fundamental parameter that governs a star’s structure and evolution. A few models such as the BME formalism exist to retrieve this information from periodic and phased-locked polarimetric variations. However, the results are affected by noise,
amplitude of the variations, and statistical biases. The method has nonetheless been successfully used on various types of binaries, such as Wolf-Rayet binaries, interacting pairs, eclipsing systems, etc.

In the era of 8- and 10-m telescopes equipped with sophisticated instruments, one can easily foresee more high-resolution imaging that takes advantage of adaptive optics, and observations of fainter targets combined with improved uncertainties. Theorists will develop more models or improve current ones to accommodate the numerous parameters found in various binary systems; this will increase the diagnostic value of polarimetric observations. Observers will greatly increase the value of their polarimetric data if they use both linear and circular polarimetry, at various wavelengths, and combine those polarimetric observations with the other more commonly used techniques (imaging, spectroscopy).

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