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Photometry, spectroscopy and micro-arcsec astrometry of binaries from space with GAIA

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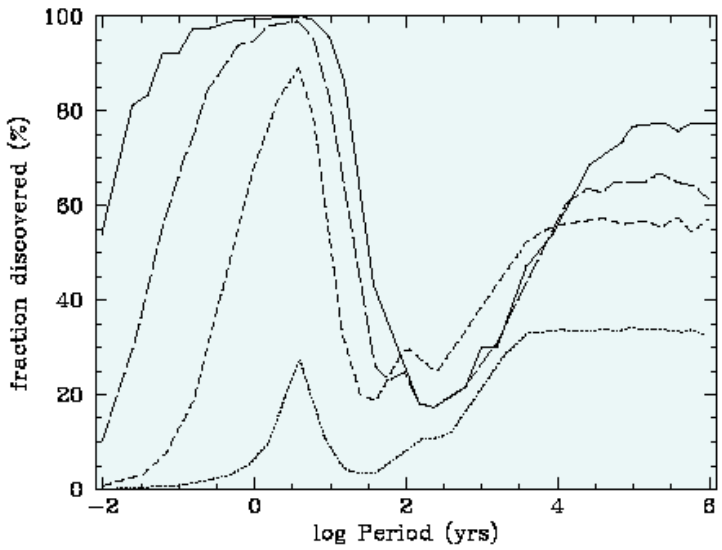

Fig. 3. Fraction of astrometric and resolved binary stars discovered by GAIA as a function of orbital period and for different magnitude ranges: $10 < V < 12.5$ (solid), $12.5 < V < 15$ (long dash), $15 < V < 17.5$ (short dash), $17.5 < V < 20$ (dotted line). Simulations were done for a distance limited sample ($d < 1$ kpc). The left maximum marks astrometric systems discovered by a sinusoidal proper motion of the brighter component, the right one is due to systems with resolved components. Adapted from ESA-SCI(2000)4.

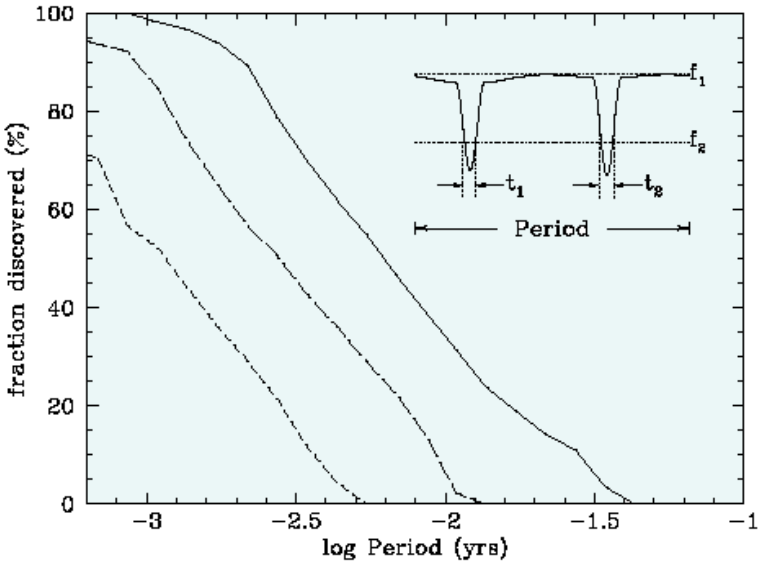

Fig. 4. Fraction of binaries discovered by their photometric variability. The components are assumed to be main sequence stars with a total mass of 2 $M_\odot$ and a flat distribution of mass ratios ($0.2 < q < 1.0$). A binary gets discovered if its light variation is pronounced enough. If the maximum flux level is f_1 we assume that the observed flux should be below f_2 for at least the time $(t_1 + t_2) = 0.08 \times$ Period. The solid curve is for a very accurate photometry where already $f_2/f_1 = 0.99$ gets detected. The long dashed one is for $f_2/f_1 = 0.95$ and the short dashed one for the least accurate photometry where $f_2/f_1 = 0.8$ is needed to bit the noise.

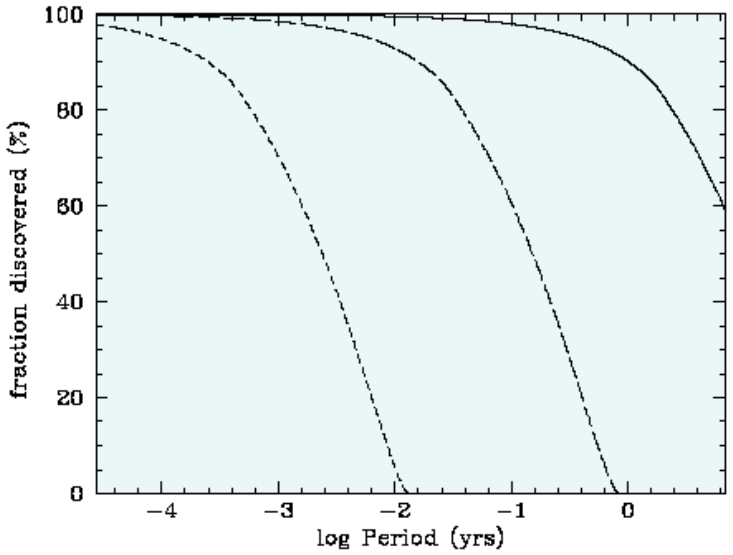

Fig. 5. Fraction of single lined spectroscopic binaries discovered by variation in radial velocity of the more luminous component. The components are assumed to be main sequence stars with a total mass of 2 $M_\odot$ and a flat distribution of mass ratios: $0.2 < q < 1.0$. The curves denote binaries with a $v \sin i$ amplitude of 5 km s^{-1} (solid), 20 km s^{-1} (long dashed) and 80 km s^{-1} (short dashed line). In the case of accurate radial velocity measurements already 5 km s^{-1} variation gets detected and virtually all binaries with periods up to a few years (i.e. the mission lifetime) get discovered. If the measurements are more noisy only large velocity amplitudes and so binaries with periods of days or less are recognized.

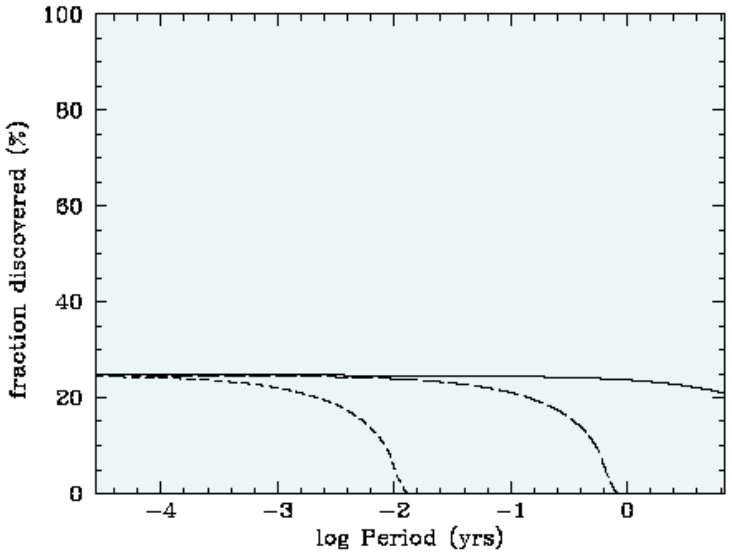

Fig. 6. Fraction of discovered double lined spectroscopic binaries. The components are assumed to be main sequence stars with a total mass of 2 $M_\odot$ and a flat distributuon of mass ratios $0.2 < q < 1.0$. We assume that lines from both stars can be measured if the more massive star has at most twice the luminosity of the fainter one. This limits occurence of double lined systems to $0.8 < q < 1.0$. The curves denote binaries with a $v \sin i$ amplitude of the more massive component of 5 km s^{-1} (solid), 20 km s^{-1} (long dashed) and 80 km s^{-1} (short dashed line). Interpretation of the required accuracy of radial velocity measurements is similar to Fig. 5.

DISTANCE DETERMINATION FOR
ECLIPSING DOUBLE-LINED BINARY STARS

System Designation	MEASURED DISTANCE (pc) Hipparcos parallax			Binary analysis[a]
	min	aver.	max	
V505 Per	62	66	70	59 ± 4
V781 Tau	73	81	91	81 ± 1
UV Leo	83	91	103	92 ± 6
V570 Per	103	117	131	108 ± 6
V432 Aur	100	119	146	124 ± 10
UW LMi	114	129	150	100 ± 7
GK Dra	246	297	373	313 ± 14
CN Lyn	233	362	813	285 ± 32
OO Peg	304	445	840	295 ± 17

[a]From Munari et al. (2001b), Zwitter et al. (2003), Marrese et al. (2003).

Conclusions

- GAIA may discover ~7 x 10^6 eclipsing binaries.
- At least ~ 10^4 of these will be double-lined and brighter than V=15, permitting a reasonable quality determination of their physical parameters.
- GAIA data will allow for a direct sampling of properties of multiple stars at any orbital period, from minutes to millions of years.
- Co-evity of components in such systems will allow unprecedented tests of evolutionary theories and formation scenarios.
- Accuracy of distances obtained from analysis of binary systems located at the outskirts of the Galaxy or beyond will rival or supersede those obtained by astrometric measurements.