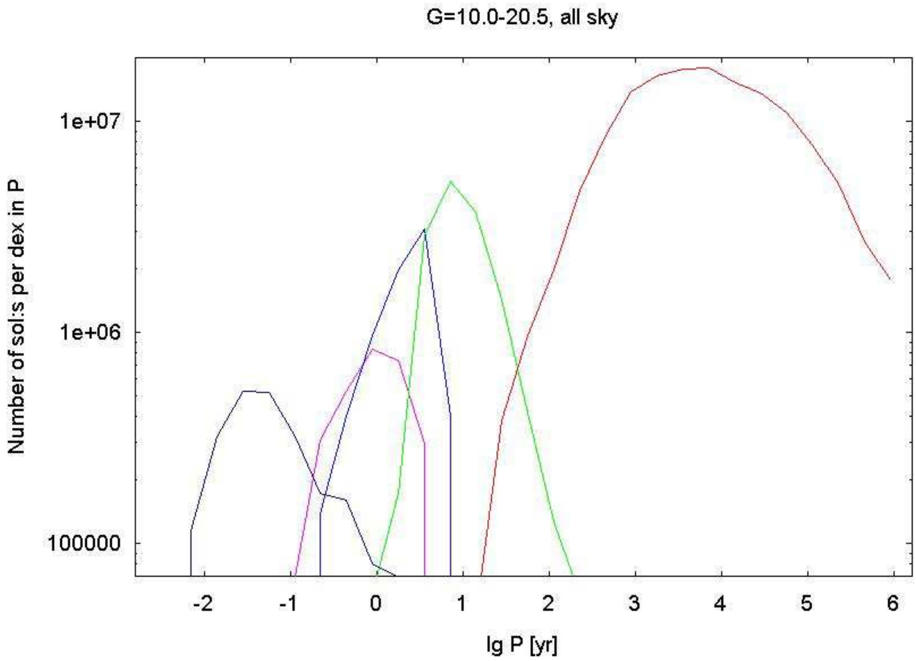

Estimated numbers of binary solutions from Gaia as a function of period. From left to right: $\sim 7{\times}10^5$ radial-velocity orbits, $8{\times}10^5$ radial-velocity-plus-astrometry orbits, $2{\times}10^6$ astrometry orbits, $4{\times}10^6$ non-linear proper-motion systems, and $4{\times}10^7$ resolved binaries. Gaia will also provide solutions for millions of eclipsing binaries with periods below 10^{-2} yr.

One of Gaia's unique features is the well-defined sampling and subsequent observations of tens of millions of binaries over the entire sky. Even though by the time Gaia will be operational, large ground-based telescopes and interferometers may have resolutions and light-collecting areas exceeding those of Gaia, thus enabling detailed studies of individual binaries and multiples, relatively few objects will have been observed with such instruments. Moreover, the observed targets will have been selected basically at random and thus do not form a complete sample in any sense.

As a result of its aperture size, Gaia will resolve all binaries with separations above some 20 mas which have moderate magnitude differences between the components. Many such systems exist and these will form the bulk of the 'Gaia Binary Catalogue'. Since distances of Gaia binaries will tipically exceed a kilo-parsec, orbital periods of most of them will be too long for orbit determination. Nevertheless, direct observational data in the form of the distributions of separations and magnitude differences will already provide a unique handle on the basic $f(a)$ (semi-major axes) and $f(q)$ (mass ratio) distributions.

One of Gaia's strengths is its extreme sensitivity to non-linear (proper) motions. Large fractions of the astrometric binaries with periods in the range 0.03 – 30 yr will be recognised immediately, If the period of such systems is below 7 – 8 yr, it will be possible to determine a photocentre orbit. At the bright end (up to 15-th magnitude), radial-velocity observations will define large numbers of shorter-period binaries. At the shortest periods, Gaia will (photometrically) observe millions of eclipsing binaries, mostly too faint for radial-velocity observations. In summary, Gaia will observe binaries with periods between hours and millions of years, but the actual 'detection-efficiency' will be a complex function of period, distance, and absolute magnitude.

The figure above shows results from detailed simulations. The five curves give the expected total number of binary-star solutions from five solution methods. From left to right: the radial-velocity observations that give short-period orbits are only available for the brightest stars. The next two curves refer to combined radial-velocity-plus-astrometry and the astrometry-only orbits. The 'non-linear proper motion' detections peak at a period of 10 yr since these systems are resolved at longer periods. To these five solution types should be added a large number of eclipsing binaries with periods below 10^{-2} yr. The 'all-sky/all magnitude' curves shown above are a combination of results from all distances. Looking at a nearby sample ($<$ 500 pc), many resolved binaries have periods short enough for orbit determination, i.e. there is good overlap between the solution methods, and hence binaries of all periods may be observed. For more distant samples, there are no resolved orbits, and as shown by the dip in the figure, binaries with a period of about 100 yr will be hard to detect with Gaia.