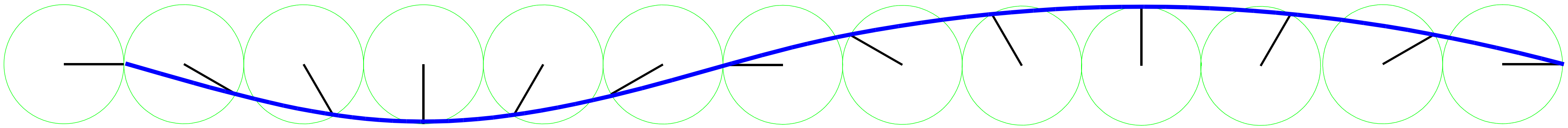
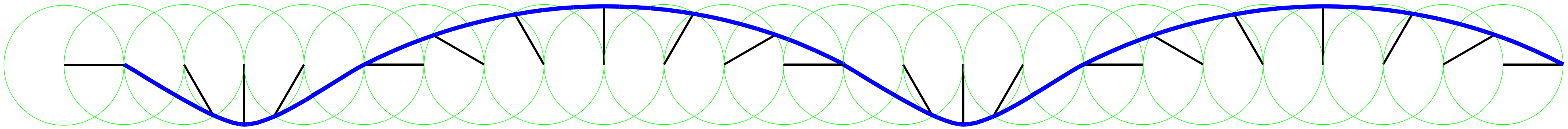
Planetary movement through space relative to the galactic centre

The speed of a star probably outstrips the speed of its planets. Were that not so the track of a planet through space might resemble one of these patterns:

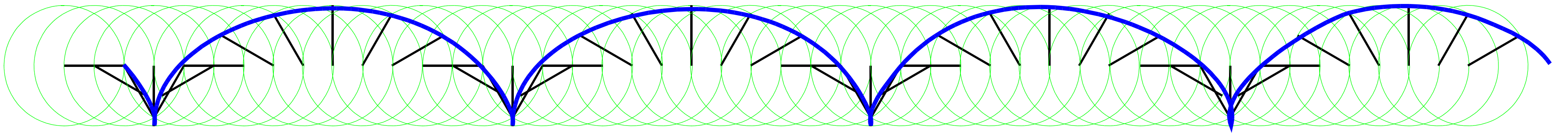
1. Planet orbits once whilst star progresses 12 orbital diameters — ratio 1:12



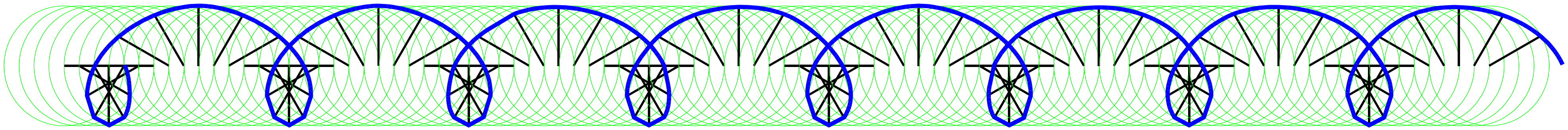
2. Planet orbits twice whilst star progresses 12 orbital diameters — ratio 1:6



3. Planet orbits four times whilst star progresses 12 orbital diameters — ratio 1:3



4. Planet orbits eight times whilst star progresses 12 orbital diameters — ratio 1:1.5



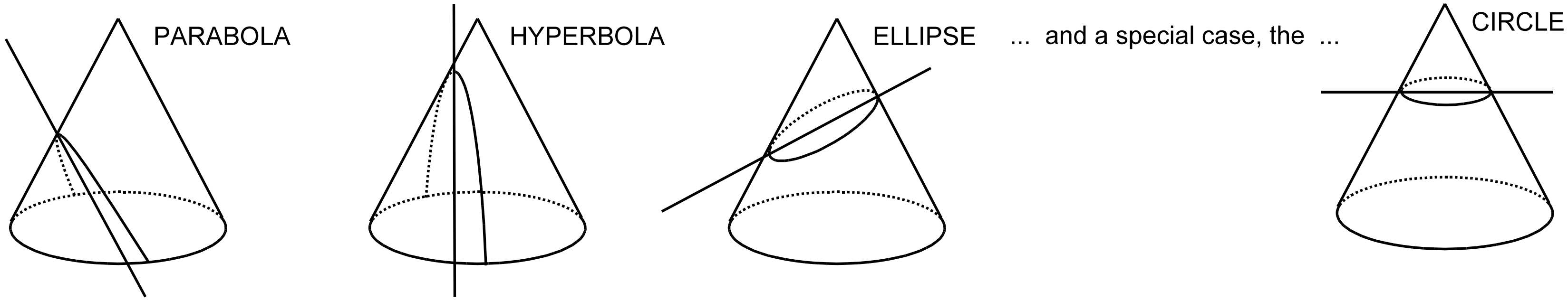
These sketches assume that motion is perfectly circular. In reality, orbits of heavenly bodies are basically elliptical, as discussed on the following page

Planetary orbits

In ancient times it was thought that everything in Creation was 'perfect', so naturally it was assumed that the movement of stars and planets through the heavens would be perfect. To the ancients the circle was seen as a perfect shape, so to conform with the idea of perfection, it seemed that heavenly bodies must move around in circles. However, despite the efforts of the Church to punish people who doubted this idea, that was not the end of the matter. First, observers proposed the idea of epicycles [see http://en.wikipedia.org/wiki/Deferent_and_epicycle] to account for the unusually eccentric motions they saw. That idea persisted despite its imperfections and complications until the geocentric theory had to give way to the heliocentric theory (things in our solar system did not orbit the earth, but the sun: the sun was the centre of our local piece of the heavens). Then things seemed to slot into place, as long as one allowed that orbits were not after all perfect circles, but ellipses [see http://en.wikipedia.org/wiki/Ellipse].

Why was this such a shock? Well, when the Church (the authority for natural science in those days) had decreed that God worked in circles, anything else was treated as blasphemy, worthy of dire penalties like being burned at the stake or even being excommunicated. However not even the Church could deny clear evidence for ever. Eventually the ellipse took its rightful place in our understanding of the divine scheme of things.

Actually, we should consider the ellipse as divine perfection, not the circle. The ellipse is a lovely shape generated by a simple algorithm or even a slice from a right circular cone; it is a conic section. Conic sections are of three basic types:



Cut a cone with a knife parallel to one of the sloping sides, and you have a parabola. Cut vertically, and you have a hyperbola; that is different from a parabola, for if you imagine the cone with its mirror image upside down poised on its tip, you can imagine another curve generated upside down; a hyperbola has two disconnected parts: cunning, isn't it! If instead you cut your cone obliquely, you have an ellipse; now we are getting there, for if our cut is exactly parallel to the base of the cone, we'll get a circle. So you can see that the circle is a special case of the ellipse.

Once we have grasped that, it's easy to imagine The Creator having lots of flexibility with ellipses, that he wouldn't have had, had he insisted (against all the advice from his mathematicians) to restrict himself to circles.

So heavenly bodies move around in elliptical orbits. Just occasionally you might find one with a perfectly circular orbit, but that would be highly unusual. In any case, because heavenly bodies respond to gravitational attraction from all other heavenly bodies, even huge distances away, their orbits are never exact ellipses.

Orbits cannot be hyperbolas, for they consist of two disconnected tracks. But we do find parabolas; we can think of parabolas as extreme examples of ellipses in which the other end is so far away you can never get there. Comets have very long ellipses, and some things that enter our solar system look as though they have parabolic courses through the sky. We can't really call those orbits though.

Why do ellipses 'work'? It's all down to gravity. The force of gravity is directly proportional to the masses of objects and inversely proportional to (the square of) the distance between them. So with a heavy body like the sun and a lighter body like a small comet, gravity pulls them together; strongly when they are nearer together but less strongly when they are farther apart. When they are close, with strong attraction, the comet speeds up. As it whizzes round the back of the sun, it's going very fast, but then it slows down again and continues on its long ***elliptical*** orbit into the far distance. The planets respond to gravity in the same way, but their orbits are more nearly circular.