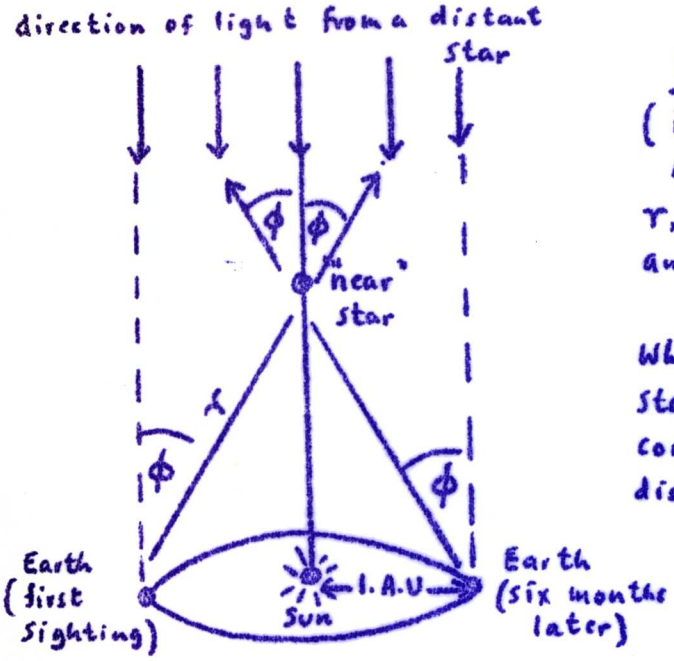
Astronomical Parallax (abbreviated to "parallax")

① How far away from the Earth is a star with a parallax of 0·25 seconds of arc? Express your answer in astronomical units.



Note that the parallax is defined as half the angle between the two sighting lines, (i.e., the parallax is defined for a base-line of one Earth orbital radius). The distance, r, to the star can be calculated (using the small-angle approximation) from $r = \frac{1}{\phi}$ a.u., where ϕ is in radians. Even for the nearest stars, ϕ is smaller than one second of arc; consequently the difference between the Sun-star distance and the Earth-star distance is negligible.

Why are we not able to use the orbital diameter of the Earth when measuring the angular positions of the planets?

② The diagram shows the "near" star located directly above the Sun on an imaginary line perpendicular to the plane of the orbit of the Earth. How should the geometry be modified for stars in other positions relative to the orbit of the Earth?

③ The star commonly called α (alpha) Centauri in the southern hemisphere constellation of Centaurus is really a triple star system. One of these stars, Proxima Centauri, is at present closer to the Earth than the other two. In fact, our nearest stellar neighbour. It has an observed parallax of ϕ = 0·763 seconds of arc. Calculate the distance of Proxima Centauri in parsecs. What is this distance in metres?

Units of Distance

	km	A.U.	l.y.	Pc
1 km	1	6.7×10^{-9}	1.1×10^{-13}	3.2×10^{-14}
1 A.U.	1.5×10^{8}	1	1.6×10^{-5}	4.8×10^{-6}
1 L.Y.	9.5×10^{12}	6.3×10^{4}	1	3.1×10^{-1}
1 Parsec	3.1×10^{13}	2.1×10^{5}	*3·3	1

* 3·258

With modern instrumentation, we can just about detect a parallax of 0·005 seconds of arc (equivalent to a distance of 200 pc) If we require that the uncertainty be no greater than ± 10 per cent, the parallax must be larger than 0·05 seconds of arc. Only about seven hundred stars lie within this 20 pc limit.