Note 11a(6): Calculating the Mass of the Sun's Binary Object.

From the orbital interval of:

$$\tau = 25,770 \text{ years} = 8.14 \times 10^{11} \text{ secs} \quad -(1)$$

the angular frequency is:

$$\omega = \frac{2\pi}{\tau} = 7.72 \times 10^{-12} \text{ rad s}^{-1} \quad -(2)$$

$$= 50.28 \text{ arcseconds a year.}$$

By Kepler's third law:

$$a^3 = G(m_1 + m_2)\tau^2 / (4\pi^2) \quad -(3)$$

Here a = semi major axis, m_1 = mass of the sun, and m_2 = mass of attracting object.

$$\boxed{v = \omega a} \quad -(4)$$

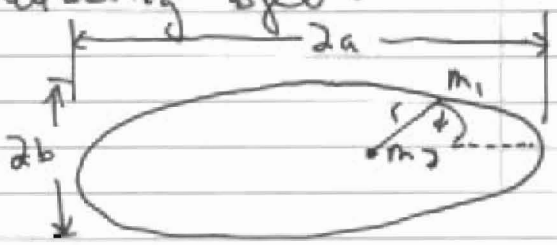

Table of Results

$m_2/(m_1+m_2)$	$a/(10^{14}\text{m})$	$v/(\text{km s}^{-1})$
2	1.65	1.27
8	2.62	2.02
80	5.64	4.36
800	12.16	9.39
8 000	26.22	20.22
80,000	56.43	43.56
800,000	121.60	93.57
8×10^6	262.35	201.90
8×10^7	564.30	434.30

The sun's orbital velocity around the centre of the galaxy is 600 km s^{-1}. The result from the gravitomagnetic equation is:

2)

$$v \sin\theta = 70.8 \text{ km s}^{-1}$$

Therefore:

$v = 600 \text{ km s}^{-1}$ if $\sin\theta = 0.118$

i.e. $\theta = 6.8°$. This means that the angle between the earth's $\underline{g}$ and the velocity $\underline{v}$ is $6.8°$. For v of 600 km s^{-1}:

$$a = \frac{6 \times 10^{5}}{7.72 \times 10^{-13}} = 7.8 \times 10^{16} \text{ m s}^{-1}$$

and $$m_2 = \frac{4\pi^2 a^3}{G\tau^2}$$

$$= 4.24 \times 10^{38} \text{ kgm.}$$

$$= \frac{4.24 \times 10^{38}}{1.99 \times 10^{30}}$$

$$m_2 = 2.13 \times 10^{8} \text{ sun masses}$$

$$a = 7.8 \times 10^{16} \text{ m}$$

$$v = 6.0 \times 10^{5} \text{ m s}^{-1}$$

Radius of Milky Way = 60,000 light years

Earth to galactic centre = 30,000 light years

Period for solar system to circle MW

$$= 2.25 \times 10^{8} \text{ years.}$$

30,000 light years $= 3 \times 10^{4} \times 3 \times 10^{8} \times 3.16 \times 10^{7}$ metres

$$= 2.84 \times 10^{20} \text{ metres}$$

If we chose $v \sin\theta = 70.8 \text{ km s}^{-1}$

then $a = \frac{7.08 \times 10^{4}}{7.72 \times 10^{-12}} = 9.17 \times 10^{15} \text{ m s}^{-1}$

and $n = 1.3 \times 10$ sun masses

$v \sin\theta = 70.8$ km s^{-1}

$a = 9.17 \times 10^{15}$ m s^{-1}

$n = 1.3 \times 10^{6}$ sun masses

Solar system to centre of galaxy distance

$= 2.84 \times 10^{20}$ metres

Distance of Neptune from sun $= 4.47 \times 10^{12}$ metres