COLLISIONS IN SPACE

By Chidiebere M. Dimkpa,

Researcher of Mathematics and Physics,

Applied Intelligence Research,

Nigeria.

Email: chidiebere.dimkpa@hotmail.com

Postulate 1: *A body can only move with constant velocity if it moves in a space in which no other bodies exist(if it moves in a vacuum).*[i]

[i] asserts that due to Newton's Law of Gravitation, provided a body exists in the space in which another body moves, such a body must exert a non-zero force of gravity on the moving body, constituting a non-zero net force which acts on it, and hence providing an acceleration, no matter how small.

Following [i], it can be seen that *provided a body does not move in a vacuum, it must accelerate*. However, in some cases, such acceleration is approximately zero, and can be neglected.

Newton's law can be re-stated in terms of the acceleration which a non-zero force of gravitational attraction induces in a body moving with constant velocity:

For the body which moves with constant velocity, v_0, its acceleration and net force which acts upon it is zero. However, as it enters the *field of gravity* of a massive body, its net force is not zero, and it accelerates towards the body.

The "field of gravity" is defined as: *The spherical region of space, the center of which is occupied by the attracting body, and whose radius is* *that distance for which the acceleration induced in a body which moves towards it is just greater than zero.*

The *radius* of the field of gravity is called the *range of gravitational force*, and is given in terms of the acceleration induced in the moving body as:

$$\Re = \sqrt{(GM_C/A)} \quad [1]$$

following this, we may assume that $A = 10^{-100}$ m/s² which is the mathematical beginning of the spectrum of zero. We must chose this value because it will mean that $\Re$ is the *maximum distance for which such a body can induce any acceleration at all*. Inserting this value in [1], we obtain:

$$\underline{\Re} = (10^{50})\sqrt{(GM_C)} \quad [1^*]$$

for the Earth($M_C = 5.98 \times 10^{24}$ kg), $\underline{\Re}$ is

$$\underline{\Re} = 1.997 \times 10^{57} \text{ m} = 2.1 \times 10^{41} \text{ ly}$$

hence, provided a body is *within* this distance from the Earth, it is accelerating towards the earth even if it was initially moving with constant velocity.

We may express [1] more generally in terms of *any* distance(corresponding to a smaller spherical shell within the field shell) from the center of the field of gravity as

$$R=\sqrt{(GM_C/A)} \quad [2]$$

[2] implies that the closer a body gets to the center of the field of gravity, the greater its acceleration. When we make A the subject of [2], the following postulate is established:

Postulate 2: *The acceleration of a body moving with constant velocity once it enters the field of gravity is the same as if the body were moving in a circle around the center of the field of gravity, such that the induced acceleration is simply the radial(centripetal) acceleration.* [ii]

From [2],

$$A = GM_C/R_0^2 = v_0^2/R_0 \quad [iii]$$

Where v_0 is $\sqrt{(GM_C/R_0)}$

Let it be known that [iii] pre-defines the constant speed, v_0 , of a body which is a distance, R_0 ,from the center of the field of gravity due to M_C, according to both the principle of uniform motion in a circle and Newton's law of gravitational attraction.

This permits us to define a single radius(R_0) which we use to compute the acceleration of the body, and this radius is a function of the body's initial velocity(v_0):

$$R_0 = GM_C/v_0^2 \qquad [3]$$

Using R_0, we get a single value for A, A_0, which is given as follows:

$$A_0 = v_0^4/GM_C \qquad [4]$$

Using [4], we may give the *instantaneous velocity* of the body as it accelerates towards the center of the field of gravity:

$$v = v_0 + A_0 t,$$

$$v = v_0 + v_0^4 t/GM_C \quad [iv]$$

if we assume that the moving body is to collide with the attracting body, it would be useful to derive a *time of collision* based on [4] :

the acceleration which the body has at a distance R_0 from the center of the field of gravity is the same as the centripetal acceleration it would have if it was travelling at a speed, v_0, in a circle around the center of gravity a distance R_0 from it.

Hence once the distance of the moving body from the center of the field of gravity is R_0, [4] becomes valid, and we may compute the time of collision of the moving body with the center of the field of gravity.

The distance, S, covered by the body as it accelerates in a straight line is:

$$S = v_0 t + ½ A_0 t^2$$

$$S = v_0 t + v_0^4 t^2/2GM_C \quad [v]$$

When $S=R_0$, the moving body will collide with the center of the field of gravity, and the time of collision(t_0) is given as follows:

$$t_0 = GM_C(\sqrt{3} - 1)/v_0^3 \quad [5]$$

hence we see that the time of collision is independent of the mass of the attracted(accelerating) body, and depends on the initial velocity of the attracted body as well as the mass of the attracting(more massive and relatively stationary) body.

Postulate 3: *Once a body which initially moves with constant velocity enters the sphere of influence of the gravity of a relatively stationary and more massive body, it must accelerate towards the center of such a body, and since the net force which acts upon it pulls it toward the center of such a body, with the non-intervention of other factors comes the inevitable collision of the two bodies.*[vi]

In closing, let us take an example of an extraterrestial collision:

Example: NASA satellites detect an asteroid which is 1.6 light years away from the sun, and which is moving with a velocity of 96.2 m/s in the direction of the sun . If the gravities due to other bodies along its path can be ignored, how long do Earth's Joint Extraterrestrial Defence Forces (JEDF) have to blast it out of the course of the sun?

Solution

The average person, ignoring the gravitational effects of the sun, will calculate as follows:

Time = distance/speed

Time = $(1.513 \times 10^{16}$ m)/(96.2 m/s) = 4,987,205.33 years

The actual time can be calculated using [5] as follows:

$$t_0 = GM_C(\sqrt{3} - 1)/v_0^3,$$

$$G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$$

M_C = mass of sun = 1.99 X 10^{30} kg

v_0 = 96.2 m/s

t_0 = 3,460,894.107 years

that's a difference of 1,526,311.22 years! and it is only 69.4% of the incorrectly measured time.

References

1. several physics texts, including electronic texts, but most notably, University Physics, ninth edition, by H. D. Young and R. A. Freedman. Addison Wesley Publishing Company, Inc (1996)

2. several of my papers, written for Applied Intelligence Research

3. several physics websites and depositories.