Applied Physics Research; Vol. 7, No. 4; 2015
ISSN 1916-9639 E-ISSN 1916-9647
Published by Canadian Center of Science and Education

Dynamic Universe Model Predicts the Live Trajectory of New Horizons Satellite Going To Pluto

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Received: March 16, 2014 Accepted: May 27, 2015 Online Published: July 31, 2015

doi:10.5539/apr.v7n4p63 URL: http://dx.doi.org/10.5539/apr.v7n4p63

Abstract

In this paper, Dynamic Universe Model is used for prediction of trajectory of New Horizons (NH) satellite from 3rd Jan 2009 to 1st Jan 2017, taking trajectory ephemerides data of Jan 1&2, 2009 from NASA's official web of NH, as basis. The NH web gives data up to 1st Sept 2015 as on 20 Jul 2014. The present calculated data from Dynamic Universe Model is given up to 1st Jan 2017, which is 16 months more than the available data. And further trajectory data also can be calculated. It may please be noted the error percentage in predictions went to a maximum in error percentages (0.24 %, -0.0009 %, -0.05 %) compared with NH web for the same date in XYZ coordinates, where as error percentages started from -0.002%, 0.00016 %, -0.0003 % for XYZ coordinates respectively.

Keywords: dynamic universe model, New Horizons (NH) satellite, Pluto Mission, Satellite Trajectory calculations, Pioneer Anomaly

1. Introduction

1.1 Using Dynamic Universe Model for New Horizons Trajectory:

Dynamic universe model can explain Pioneer anomaly, i.e., the higher gravitational attraction forces experienced towards SUN after Jupiter, in a similar way it can also explain NH trajectory anomalies and predict for few more years than the present predictions.

New Horizons (NH) is NASA's artificial satellite now going towards to the dwarf planet Pluto. It is the first spacecraft to go near and study Pluto and its moons, Charon, Nix, and Hydra. NH is expected to go near to Pluto in 2015. Later NH will be used for studying Kuiper Belt. The behavior of NH is similar to Pioneer Space craft as NH traveling in a similar manner.

1.2 NH Launch History:

The New Horizons spacecraft was successfully launched on January 19, 2006 in a three-stage rocket, took a Jupiter-gravity-assist (fly by) in 2007 to go into a trajectory to Pluto (jpl.nasa.gov). The spacecraft will encounter Pluto on July 14, 2015 after a 9.5-year journey from launch. On 14 July 2014, mission controllers performed a sixth trajectory maneuver (TCM) correction since its launch to enable the craft to reach Pluto at the mission specific time on 14 July 2015. When NH started its journey, Pluto was considered as one of the planets. Now Pluto is one of the dwarf planets near the Kuiper belt. Now NH has crossed orbit of Uranus. On 25 Aug 2014 the probe will pass Neptune's orbit. This will be the fifth planetary orbit the spacecraft crosses. These ephemerides data is taken from JPL web as on 28th June 2009 (JPL Planetary and Lunar Ephemerides, 2014).

1.3 The Ephemerides Data:

The ephemerides data of NH from JPL as on 01 & 02, Jan.2009@00.00:00 hrs was taken as basis. The initial configuration of solar system in HELIO CENTRIC ECLIPTIC XYZ VALUES of solar system, nearby stars, Glob Cluster Groups, Galaxy center, Milkyway parts etc., were taken. And for Andromeda and Triangulum Galaxy also these xyz Cartesian coordinates in meters were collected as on 02.Jan.2009@00.00:00 hrs. All this data was shown in Table 1 (Appendix). Table 1 is given in the annexed file "Vak NH Table 1.xls". It shows full table of input values. The Cartesian coordinates of xyz velocities of planets of solar system were collected from JPL ephemerides and shown in Table 1. Velocities of other bodies were collected from different sources. It may please be noted, even if the velocities are unknown for some of the bodies, this Dynamic Universe model will calculate those unknown velocities, depending on positions of all the bodies. In a few iterations the whole system will stabilize. And Table 2 shows Velocities of NH, planets and other bodies.

By using this initial data, the 8 years data from 03 Jan 2009 was calculated using Dynamic Universe Model's SITA (Simulation of Inter–intra-galaxy Tautness and Attraction forces) software. Here I used the time step of "one day" for all iterations. There were 2919 iterations up to 1st Jan 2017 of duration one day each. Results are given in Table 3, a supplementary file.

The data from 03-Aug-2009 was calculated and this predicted data was compared with 03-Aug-2009 ephemeris and so on. The predictions for NH by Dynamic Universe Model are comparable with ephemerides data. The differences between predicted data and ephemerides data are compared and were shown Table 5 & 6. In these tables, the first three columns after date give Dynamic Universe Model predictions based on 02 &01 Jan-2009 00:00 hrs data with daily time step. Next three columns gives ephemerides from JPL. Dynamic Universe Model can predict further to 01-Jan-2017 without any problem. Any other part of the trajectory data can be calculated.

'SITA Calculations' software was developed about 20 years back for the mathematical frame work of Dynamic Universe Model of Cosmology. It is based on Newtonian physics. It is a solution to classical N-body problem using singularity free tensors. Classical N-body problem is the same old problem that was announced by King Oscar II and struggled by Poincare to solve in vain in year AD1888 for general N-body problem. SITA was tested extensively for so many years by me. This was first developed on 486 based PC of those days; the same software was used repeatedly for so many years for solving deferent Physical problems on Different PCs and Laptops.

Just considering gravitation of the Sun alone is not sufficient. Many physicists require some other additional factors to be considered, some points like Nucleonic pulse device etc, were considered but ruled out. Main point left was like considering simultaneous and dynamical gravitation effects of other planets. This work is a theoretical and computational work and the overall combined consolidated results as shown are in this paper. (Full set of results are given as additional files as they are lengthy.)

2. New Horizons Trajectory Calculations:

New Horizons trajectory can be calculated using Chebyshev polynomials fit between known and measured positions as well as for extrapolating external points or Dynamic Universe Model can be used from the beginning. In this Dynamic Universe model no interpolation methods are used.

2. 1 New Horizons Trajectory Ephemerides Given by:

Folkner et al. (2014) used planetary and lunar laser ranging data for calculation of ephemerides. JPL of NASA followed this system fully. Further details can be found from t JPL Planetary and Lunar Ephemerides 2014, web page readme. *Their ephemeris include dynamical model a frictional damping between the fluid core and the elastic mantle. The JPL planetary ephemerides are saved as files of Chebyshev polynomials (see Holger Dette, 1995) fit to the Cartesian positions and velocities of the planets, Sun, and Moon, typically in 32-day intervals. These predictions are corrected by measuring the satellite positions at some intervals.*

3. Other Results from Dynamic Universe Model:

Dynamic universe model explains discrepancies of Pioneer anomaly, published by Nonlinear Studies, a mathematical Journal from USA (Gupta, Murty, & Krishna, 2014). NH also faced the similar problem as Pioneer satellite. Dynamic Universe model successfully explains anomalous trajectory problems faced by both the interplanetary missions.

Now let us see what Dynamic Universe Model of Cosmology is… It uses tensor mathematics based on Newtonian physics. This mathematics used here is simple and straightforward. All the mathematics and the Excel based software details are explained in the three books published by the author (Gupta, 2010, 2011a, 2011b). In the first book, the solution to N-body problem-called Dynamic Universe Model (SITA) is presented; which is singularity-free, inter-body collision free and dynamically stable. This is the Basic Theory of Dynamic Universe Model published in 2010. The second book in the series describes the equations and SITA software in EXCEL emphasizing the singularity free portions. It explains more than 21,000 different equations (2011). The third book describes the SITA software in EXCEL in the accompanying CD/DVD emphasizing mainly HANDS ON usage of a simplified version in an easy way. The third book contains explanation for 3000 equations instead of earlier 21,000 (2011). With this same SITA setup, many physical problems were solved, which are otherwise not possible. For using this SITA, we have to give the initial values of Masses and Cartesian X Y Z "coordinates of Positions, Velocities, & Accelerations". Feeding accelerations is not compulsory. Velocities are also not very important, after little iteration of calculations, all the three dimensional Velocities and accelerations will be formed automatically. A point to be noted here is that the Dynamic Universe Model never reduces to General relativity on any condition. The fourth book (2012) in the series on Dynamic Universe Model: SITA, gave simulations that predicted the existence of the large number of Blue-shifted Galaxies in 2004, ie., more than about 35 ~ 40 Blue-shifted Galaxies known at the time of Astronomer Edwin Hubble in 1930s. The far greater numbers of Blue-shifted galaxies was confirmed by the Hubble Space Telescope (HST) observations in the year 2009.

In the VLBI paper the author has shown the discussions by other authors, saying that, there are other influencing factors other than Sun and other planets are also to be accounted for. The Dynamic Universe Model extends into Micro world mathematically to explain VLBI deviations. Being a singularity free N-body problem solution Dynamic Universe Model offers an answer for the above problem, as it can consider mutual gravitational effect of simultaneously and dynamically changing planets, stars, Milkyway center, other parts of Milkyway and other Galaxies etc. In that VLBI paper we show how to explain the variations in the Gravitational deflection (bending) angle as plotted against solar elongation angle Φ, using Dynamic Universe Model. For doing so, the capabilities of Dynamic Universe Model are extended into Micro world or the Photon/Particle zoo. Micro world is nothing but the masses of light photons and radio wavelength photons, Neutrinos, electrons and protons etc. That is, this micro world is a subset of Quantum Mechanics, dealing with masses only. Dynamic Universe model can calculate the simultaneous gravitational effect of many gravitating bodies like Sun, planets, local stars etc., while considering their dynamic movements. The required additional mathematics is in the mathematical section along with the original set. Using these extended capabilities into SITA programming, the setup of solar system was as on 01.01.2000@00.00:00 hrs. Using Heliocentric ecliptic xyz values and try sending the radio photon from different directions i.e., in different solar elongation angle Φmin and trace the path of radio photon. Here 76 different xyz coordinates and different directions were taken for radio photons with the same status of solar system as on 01.01.2000@00.00:00 hrs. The only change from experiment to experiment is the initial position and direction of the photon. All these theoretical experiments were designed in such a way, the photon goes grazingly near Sun or at the minimum distance from the center of Sun at the moment of time as on 01.01.2000@00.00:00 hrs, precisely. That means all the Solar system setup was kept constant and changed the Solar Elongation Angle only, taking into account all the dynamic movements of planets and the their gravitational fields on the fast moving photon. Each of these computationally intensive theoretical experiments took a time 15 min at the lowest to 5 hours at the highest, on a recent HP Laptop, depending on the number of iterations. This paper was presented as a talk at COSPAR-12 (H0.2-0010-12) and published (Gupta, 2014).

All the mathematics and the Excel based software details are explained in the three books published by the author (GUPTA, 2010, 2011a, 2011b) In the first book, the solution to N-body problem-called Dynamic Universe Model (SITA) is presented; which is singularity-free, inter-body collision free and dynamically stable. This is the Basic Theory of Dynamic Universe Model published in 2010 (GUPTA, 2010). The second book in the series describes the SITA software in EXCEL emphasizing the singularity free portions. It explains more than 21,000 different equations (2011)(GUPTA, 2010a). The third book describes the SITA software in EXCEL in the accompanying CD / DVD emphasizing mainly HANDS ON usage of a simplified version in an easy way. The third book contains explanation for 3000 equations instead of earlier 21000 (2011)(GUPTA, 2010b).The fourth book (2012) (GUPTA, 2012) in the series on Dynamic Universe Model: SITA, gave simulations that predicted the existence of the large number of Blue-shifted Galaxies in 2004, ie., more than about 35 ~ 40 Blue-shifted Galaxies known at the time of Astronomer Edwin Hubble in 1930s. The far greater numbers of Blue-shifted galaxies was confirmed by the Hubble Space Telescope (HST) observations in the year 2009.

The theoretical Circular velocities are different to that of observed, the missing mass (Dark matter) arises due to Calculation error, there is no other reason and dark matter does not exist in reality. In a present paper, about “there is no dark matter” it was shown that concepts like relative constant Mass, variable mass and missing mass etc., are not required. And the details of earlier publications, in books as well as papers are available in the same paper. One can refer to the same paper for main foundations and a general introduction for Dynamic Universe Model (Gupta, 2014). One can see the references in this paper for the details...

SITA solution can be used in many places like currently unsolved applications like Pioneer anomaly at the Solar system level, Missing mass due to Star circular velocities and Galaxy disk formation at Galaxy level etc. Here we are using it for prediction of blue shifted Galaxies.

Dynamic Universe model does NOT depend on speculation for its equations (the warping of space comes to mind). It is based on hard observed facts. As I am writing this, cosmology is becoming more and more speculative, concerning ad hoc hypothesis bolstering theory.

3. The Mathematical Formulations: Into the Micro World

3.1 Original Theoretical Formation (Tensor):

Let us assume an inhomogeneous and anisotropic set of N point masses moving under mutual gravitation as a system and these point masses are also under the gravitational influence of other additional systems with a different number of point masses in these different. For a broader perspective, let us call this set of all the systems of point masses as an Ensemble. Let us further assume that there are many Ensembles each consisting of a different number of systems with different number of point masses. Similarly, let us further call a group of Ensembles as Aggregate. Let us further define a Conglomeration as a set of Aggregates and let a further higher system have a number of conglomerations and so on and so forth.

Initially, let us assume a set of N mutually gravitating point masses in a system under Newtonian Gravitation. Let the α^{th} ^point mass has mass m_α, and is in position x_α. In addition to the mutual gravitational force, there exists an external ϕ_{ext}, due to other systems, ensembles, aggregates, and conglomerations etc., which also influence the total force F_α acting on the point mass α. In this case, the ϕ_{ext} is not a constant universal Gravitational field but it is the total vectorial sum of fields at $x_\alpha$due to all the external to its system bodies and with that configuration at that moment of time, external to its system of N point masses.

$$\text{Total Mass of system} = M = \sum_{\alpha=1}^{N} m_\alpha \quad (1)$$

Total force on the point massα is Fα, Let $F_{\alpha\beta}$ is the gravitational force on the α^{th}point mass due to β^{th}point mass.

$$F_\alpha = \sum_{\substack{\alpha=1 \\ \alpha\neq\beta}}^{N} F_{\alpha\beta} - m_\alpha \nabla_\alpha \Phi_{ext}(\alpha) \quad (2)$$

Moment of inertia tensor

Consider a system of N point masses with mass m_α, at positions X_α, α=1, 2, … N; The moment of inertia tensor is in external back ground field ϕ_{ext}.

$$I_{jk} = \sum_{\alpha=1}^{N} m_\alpha x_j^\alpha x_k^\alpha \quad (3)$$

Its second derivative is

$$\frac{d^2 I_{jk}}{dt^2} = \sum_{\alpha=1}^{N} m_\alpha \left(\overset{\circ\circ}{x_j^\alpha} x_k^\alpha + \overset{\circ}{x_j^\alpha} \overset{\circ}{x_k^\alpha} + x_j^\alpha \overset{\circ\circ}{x_k^\alpha} \right) \quad (4)$$

The total force acting on the point massα is and $\hat{F}$ is the unit vector of force at that place of that component.

$$F_j^\alpha = m_\alpha \overset{\circ\circ}{x_j^\alpha} = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\alpha m_\beta \left(x_j^\beta - x_j^\alpha\right)\hat{F}}{\left|x^\beta - x^\alpha\right|^3} - \nabla\Phi_{ext,j} m_\alpha \quad (5)$$

Writing a similar formula for F^α_k

$$F_k^\alpha = m_\alpha \overset{\circ\circ}{x_k^\alpha} = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\alpha m_\beta \left(x_k^\beta - x_k^\alpha\right)\hat{F}}{\left|x^\beta - x^\alpha\right|^3} - \nabla\Phi_{ext,k} m_\alpha \quad (6)$$

OR =>

$$\overset{\circ\circ}{x_j^\alpha} = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\beta \left(x_j^\beta - x_j^\alpha\right)\hat{F}}{\left|x^\beta - x^\alpha\right|^3} - \nabla\Phi_{ext} \quad (7)$$

And =>

$$\overset{\circ\circ}{x_k^\alpha} = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\beta \left(x_k^\beta - x_k^\alpha\right)}{\left|x^\beta - x^\alpha\right|^3} - \nabla\Phi_{ext} \quad (8)$$

Lets define Energy tensor (in the external field ϕ_{ext})

$$\frac{d^2 I_{jk}}{dt^2} = 2\sum_{\alpha=1}^{N} m_\alpha \left(\overset{\circ}{x}_j^\alpha \overset{\circ}{x}_k^\alpha \right) + \sum_{\substack{\alpha=1 \\ \alpha\neq\beta}}^{N} \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\alpha m_\beta \left\{ \left(x_k^\beta - x_k^\alpha\right) x_j^\alpha + \left(x_j^\beta - x_j^\alpha\right) x_k^\alpha \right\}}{\left| x^\beta - x^\alpha \right|^3}$$

$$- \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_j^\alpha - \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_k^\alpha \tag{9}$$

Lets denote Potential energy tensor = Wjk = $\sum_{\substack{\alpha=1 \\ \alpha\neq\beta}}^{N} \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\alpha m_\beta \left\{ \left(x_k^\beta - x_k^\alpha\right) x_j^\alpha + \left(x_j^\beta - x_j^\alpha\right) x_k^\alpha \right\}}{\left| x^\beta - x^\alpha \right|^3}$ (10)

Lets denote Kinetic energy tensor = 2 K_{jk} = $2\sum_{\alpha=1}^{N} m_\alpha \left(\overset{\circ}{x}_j^\alpha \overset{\circ}{x}_k^\alpha \right)$ (11)

Lets denote External potential energy tensor = 2 Φ_{jk}

$$= \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_j^\alpha + \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_\alpha x_k^\alpha \tag{12}$$

Hence $$\frac{d^2 I_{jk}}{dt^2} = W_{jk} + 2K_{jk} - 2\Phi_{jk} \tag{13}$$

Here in this case

$$F(\alpha) = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} F_{\alpha\beta} - \nabla_\alpha \Phi_{ext}(\alpha) m_\alpha$$

$$= \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\alpha m_\beta \left(x^\beta - x^\alpha\right)}{\left| x^\beta - x^\alpha \right|^3} - \nabla\Phi_{ext} m_\alpha \tag{14}$$

$$= \left\{ \overset{\circ\circ}{x}{}^{\alpha}(\text{int}) - \nabla_\alpha \Phi_{ext}(\alpha) \right\} m_\alpha \tag{15}$$

$$\overset{\circ\circ}{x}(\alpha) = \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\beta \left(x^\beta - x^\alpha\right)}{\left| x^\beta - x^\alpha \right|^3} - \nabla\Phi_{ext} \tag{16}$$

We know that the total force at $x(\alpha) = F_{tot}(\alpha) = -\nabla_\alpha \Phi_{tot}(\alpha) m_\alpha$

Total PE at $\alpha = m_\alpha \Phi_{tot}(\alpha) = -\int F_{tot}(\alpha) dx$

$$= -\int \left\{ \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \overset{\circ\circ}{x}{}^{\alpha}_{\text{int}} m_\alpha - \nabla_\alpha \Phi_{ext}(\alpha) m_\alpha - \right\} dx$$

$$= \int \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\beta m_\alpha \left(x^\beta - x^\alpha\right)}{\left| x^\beta - x^\alpha \right|^3} dx - \int \nabla\Phi_{ext} m_\alpha dx \tag{17}$$

Therefore total Gravitational potential ϕ_{tot} (α) at x (α) per unit mass

$$\Phi_{tot}(\alpha) = \Phi_{ext} - \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N} \frac{G m_\beta}{\left| x^\beta - x^\alpha \right|} \tag{18-s}$$

Lets discuss the properties of ϕ_{ext} :-

ϕ_{ext} can be subdivided into 3 parts mainly

ϕ_{ext} due to higher level system, ϕ_{ext} -due to lower level system, ϕ_{ext} due to present level. [Level: when we are considering point masses in the same system (Galaxy), they are at the same level, a higher level for a cluster of galaxies, and a lower level is for planets & asteroids].

ϕ_{ext} is due to lower levels : If the lower level is existing, at the lower level of the system under consideration, then its own level was considered by system equations. If this lower level exists anywhere outside of the system, the center of (mass) gravity outside systems (Galaxies) will act as (unit) its own internal lower level, practically considered into calculations. Hence separate consideration of any lower level is not necessary.

SYSTEM – ENSEMBLE:

Until now we have considered the system level equations and the meaning of $\phi_{ext.}$ Now let's consider an ENSEMBLE of system consisting of N_1, N_2 … Njpoint masses in each. These systems are moving in the ensemble due to mutual gravitation between them. For example, each system is a Galaxy, and then ensemble represents a local group. Suppose number of Galaxies is j, Galaxies are systems with point masses N1, N2 …. NJ, we will consider ϕ_{ext} as discussed above. That is we will consider the effect of only higher level system like external Galaxies as a whole, or external local groups as a whole.

Ensemble Equations (Ensemble consists of many systems)

$$\frac{d^2 I^{\gamma}{}_{jk}}{dt^2} = W^{\gamma}_{jk} + 2K^{\gamma}_{jk} - 2\Phi^{\gamma}_{jk} \tag{18-E}$$

Here $^{\gamma}$ denotes Ensemble.

This Φ^{γ}jk is the external field produced at system level. And for system

$$\frac{d^2 I_{jk}}{dt^2} = W_{jk} + 2K_{jk} - 2\Phi_{jk} \tag{13}$$

Assume ensemble in a isolated place. Gravitational potential $\phi_{ext}(\alpha)$produced at system level is produced by Ensemble and $\phi^{\gamma}{}_{ext}(\alpha) = 0$ as ensemble is in a isolated place.

$$\Phi^{\gamma}_{tot}(\alpha) = \Phi^{\gamma}_{ext} - \sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N^{\gamma}} \frac{Gm^{\gamma}_{\beta}}{\left|x^{\gamma\beta} - x^{\gamma\alpha}\right|} \tag{19}$$

As Ensemble situated in an isolated place, Gravitational potential $\phi^{\gamma}{}_{ext}(\alpha) = 0$

Therefore

$$\Phi^{\gamma}_{tot} = \Phi_{ext}(\alpha) = -\sum_{\substack{\beta=1 \\ \alpha\neq\beta}}^{N^{\gamma}} \frac{Gm^{\gamma}_{\beta}}{\left|x^{\gamma\beta} - x^{\gamma\alpha}\right|} \tag{20}$$

And

$$2\Phi_{jk} = -\frac{d^2 I_{jk}}{dt^2} + W_{jk} + 2K_{jk} \tag{13}$$

$$= \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_{\alpha} x^{\alpha}_{j} + \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_{\alpha} x^{\alpha}_{k} \tag{21}$$

AGGREGATE Equations (Aggregate Consists of Many Ensembles)

$$\frac{d^2 I^{\delta\gamma}_{jk}}{dt^2} = W^{\delta\gamma}_{jk} + 2K^{\delta\gamma}_{jk} - 2\Phi^{\delta\gamma}_{jk} \tag{18-A}$$

Here $^{\delta}$ denotes Aggregate.

This $\Phi^{\delta\gamma}$jk is the external field produced at Ensemble level. And for Ensemble

$$\frac{d^2 I^{\gamma}{}_{jk}}{dt^2} = W^{\gamma}_{jk} + 2K^{\gamma}_{jk} - 2\Phi^{\gamma}_{jk} \tag{18-E}$$

Assume Aggregate in an isolated place. Gravitational potential $\phi_{ext}(\alpha)$ produced at Ensemble level is produced by Aggregate and $\phi^{\delta\gamma}{}_{ext}(\alpha) = 0$ as Aggregate is in a isolated place.

$$\Phi^{\delta\gamma}_{tot}(\alpha) = \Phi^{\delta\gamma}_{ext} - \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N^{\delta\gamma}} \frac{Gm^{\delta\gamma}_{\beta}}{\left|x^{\delta\gamma\beta} - x^{\delta\gamma\alpha}\right|} \tag{22}$$

Therefore

$$\Phi^{\delta\gamma}_{tot}(_{Aggregate}) = \Phi^{\gamma}_{ext}(\alpha)(_{Ensemble}) = -\sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N^{\delta\gamma}} \frac{Gm^{\delta\gamma}_{\beta}}{\left|x^{\delta\gamma\beta} - x^{\delta\gamma\alpha}\right|} \tag{23}$$

And

$$\Phi^{\gamma}_{jk} = \sum_{\alpha=1}^{N^{\gamma}} \nabla\Phi^{\delta}_{ext}\, m_{\alpha} x^{\delta\alpha}_{j} + \sum_{\alpha=1}^{N} \nabla\Phi^{\delta}_{ext}\, m_{\alpha} x^{\delta\alpha}_{k} \tag{24}$$

Total AGGREGATE Equations :(Aggregate consists of many Ensembles and systems)

Assuming these forces are conservative, we can find the resultant force by adding separate forces vectorially from equations (20) and (23).

$$\Phi_{ext}(\alpha) = -\sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N^{\gamma}} \frac{Gm^{\gamma}_{\beta}}{\left|x^{\gamma\beta} - x^{\gamma\alpha}\right|} - \sum_{\substack{\beta=1\\ \alpha\neq\beta}}^{N^{\delta\gamma}} \frac{Gm^{\delta\gamma}_{\beta}}{\left|x^{\delta\gamma\beta} - x^{\delta\gamma\alpha}\right|} \tag{25}$$

This concept can be extended to still higher levels in a similar way.

Corollary 1:

$$\frac{d^2 I_{jk}}{dt^2} = W_{jk} + 2K_{jk} - 2\Phi_{jk} \tag{13}$$

The above equation becomes a scalar Virial theorem in the absence of an external field, that is ϕ=0 and is in a "steady state,"

i.e.

$$\frac{d^2 I_{jk}}{dt^2} = 0 \tag{27}$$

$$2K + W = 0 \tag{28}$$

But when the N-bodies are moving under the influence of mutual gravitation without external field then only the above equation (28) is applicable.

Corollary 2:

Ensemble achieved a steady state,

i.e.

$$\frac{d^2 I^{\gamma}_{jk}}{dt^2} = 0 \tag{29}$$

$$W^{\gamma}_{jk} + 2K^{\gamma}_{jk} = 2\Phi^{\gamma}_{jk} \tag{30}$$

This Φjk external field produced at system level. Ensemble achieved a steady state; means system also reached steady state.

$$\text{i.e.}\ \frac{d^2 I_{jk}}{dt^2} = 0 \tag{27}$$

$$W_{jk} + 2K_{jk} = 2\Phi^{\gamma}_{jk} \tag{31}$$

Equation (20) gives $\phi^{\gamma}_{tot}(\alpha)$, that is external potential field present at the system level . Combining Eqn (31) and eqn (9).

$$2\Phi_{ext} jk = \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_{\alpha} x^{\alpha}_{j} + \sum_{\alpha=1}^{N} \nabla\Phi_{ext} m_{\alpha} x^{\alpha}_{k} \tag{31-A}$$

The Equation 25 is the main powerful equation, which gives many results that are not possible otherwise today. This tensor can be subdivided into 21000 small equations without any differential equations or integral equations. Hence, this set up gives a unique solution of Cartesian X, Y, Z components of coordinates, velocities and accelerations of each point mass in the setup for that particular instant of time. A point to be noted here is that the Dynamic Universe Model never reduces to General relativity on any condition. It uses a different type of mathematics based on Newtonian physics. This mathematics used here is relatively simple and straightforward. For all the mathematics, and the Excel based software, details are explained in the three books published by the author.

4. Initial Values

4.1 Value of Mass NH Satellite:

Here in this paper the mass NH Satellite was taken as 478 kg which is taken from NH web page. The behavior shown by NH will be experienced by higher mass also. Every mass behave in the similar way.

4.2 Initial Values Table

This Table 1 contains: The initial configuration of solar system in HELIO CENTRIC ECLIPTIC XYZ VALUES of solar system, nearby stars, Glob Cluster Groups, Galaxy center, Milkyway parts , Andromeda and Triangulum Galaxy in xyz Cartesian coordinates as on 01.01.2009@00.00:00 hrs in meters were shown. See annexure A for this table. And also see the attached file **'Vak NH 133 bodies input as on Jan 02 2009.xls'** for full details.

4.2 Initial Velocities Table:

Table 2: gives the initial velocities for NH, for the planets and moon as on 01.01.2009@00.00:00 hrs in meters / sec.

Table 2. HELIO CENTRIC ECLIPTIC XYZ Velocities of solar sys

	as on 01.01.2009@00.00:00 hrs in meters / sec			
Sl. No.		Vx m/s	Vy m/s	Vz m/s
1	New Horizons Spacecraft	5934.0073	-16390.9	620.4177
2	Mercury	-13310.149	50738.4	5366.706
3	Venus	-26238.979	23164.68	1831.424
4	Earth	-29774.524	-5589.02	-0.82839
5	Mars	25138.169	1478.003	-586.391
6	Jupiter	10899.531	7598.922	-275.393
7	Saturn	-2856.9347	-9384.58	276.7304
8	Uranus	939.30316	6426.9	11.74518
9	Neptune	3202.2262	4410.465	-163.922
10	Pluto	5550	-934	-1480
11	Moon	-29314.456	-4719.09	82.3554

4.3 Full Results Table: Table 3:

The output of all the 2919 iterations data is shown in Table 3, a supplementary file attached with this paper available with web version of this paper. See "Vak NH Table 3 output values.xls". (This file is also available in addition to the above at Gupta supl, 2014). In this output files only selected data was shown. The output for each of iterations consists of large amount of data viz., new positions, velocities, accelerations in 3 xyz axes for each of 133 bodies. But all these data were not shown here. Only selected data were shown like input data of NH, its additional pull towards Sun as mission progresses, the output positions and velocities. The output data viz., Table 3 was shown in the attached files. All the column heads were shown in the first row of the file. The output data is shown as separate row for each of daily iterations in the attached file in Table 3

5. NH Predictions as Given by NH Team Web Page in 2008:

It is worth mentioning another observation. It was the year 2008, the data for NH first collected by me. Then as asked, the recent data was collected and the NH predictions were recalculated and presented here up to 2017. The predictions given by their web page in 2008 and 2014 are different. This error is obvious as NH team was not considering the gravitation effects of other planets. This is shown in this section. The Table 4 gives the predictions for New Horizons (NH) space craft as on A.D. 2009-Aug-09 00:00:00.0000 hrs as predicted by NH team in 2008. The present predictions of NH team are shown in Table 1. There are differences in present prediction for the NH and previous predictions. The data and was not rearranged and is shown in this table as it is.

JDCT	X	y	z	VX	VY	VZ

References:

Starting data given at [http://ssd.jpl.nasa.gov/horizons.cgi#top] is

Ephemeris Type [change]: VECTORS

Target Body [change] :

New Horizons Spacecraft [NH New_Horizons (Spacecraft)] [-98]

Coordinate Origin [change] :

Sun (body center) [500@10]

Time Span [change] :

Start=2009-01-01, Stop=2009-08-09, Step=1 d

Table Settings [change] :

output units=KM-S; labels=YES; CSV format=YES

Display/Output [change] :

default (formatted HTML)

=====

The website [http://ssd.jpl.nasa.gov/horizons.cgi#results] gives initial part of output as:

** ******************************

JDCT , , X, Y, Z, VX, VY, VZ, LT, RG, RR,

** ******************************

$$SOE

2454832.500000000, A.D. 2009-Jan-01 00:00:00.0000, 1.831893455702002E+07, -1.802262411312388E+09, 4.846124849130476E+07, 5.934007305388568E+00, -1.639090119518093E+01, 6.204177119092869E-01, 6.014183646564395E+03, 1.803006898266943E+09, 1.646109953796153E+01,

2454833.500000000, A.D. 2009-Jan-02 00:00:00.0000, 1.883163093861168E+07, -1.803678432152277E+09, 4.851484847298443E+07, 5.933962828747228E+00, -1.638735887443054E+01, 6.203228521582478E-01, 6.018927444267887E+03, 1.804429053040728E+09, 1.645914910252247E+01,

….

2455052.500000000, A.D. 2009-Aug-09 00:00:00.0000, 1.309131513493618E+08, -2.107161888100003E+09, 6.007219709967124E+07, 5.908152805830975E+00, -1.572533280447273E+01, 6.020855006869130E-01, 7.045137555628733E+03, 2.112079104750050E+09, 1.607205212544533E+01,

JDCT	x	y	z	VX	VY	VZ

Table 4: NH Predictions as given by their web page in 2008: This table gives the predictions for New Horizons (NH) space craft as on A.D. 2009-Aug-09 00:00:00.0000 hrs as predicted by NH team in 2008. There are differences in present prediction for the NH and previous predictions. These differences were arising as they could not consider the gravitation of other planets. The data and was not rearranged and is shown in this table as it is.

6. Results of New Horizons Spacecraft Trajectory Predictions:

The essence of Table 3 results is condensed in to Table 6. This table 6 contains FULL XYZ position data of New Horizons satellite for every day starting from 2009-Jan- 02 to 2017-Jan-01. Some of these daily position data like year beginnings and year endings are further brought into a smaller Table 5. Additionally in this Table 5, data for some important dates like TCM date 2014-Jul-14 and 2015-Sep-01 the last date for which NH data is available are also shown. Table 5 is shown in the Supplementary files.

In both these Table 5 and Table 6, the first column contains date. Next three columns contain X, Y, Z position data from the official web of NASA'NH in meters. Next three columns contain predicted X, Y, Z coordinate position data output of Dynamic Universe Model in meters. Next there columns give error as difference (%) between Dynamic Universe model's predicted data and NH ephemeris data in percentages (%). Error percentages start from -0.0022509%, 0.0001594% & -0.0002887% for XYZ coordinates respectively on 2009-Jan- 03. The NH web site gives data up to 1st Sept 2015.

The sixth trajectory maneuver (TCM) correction since its launch to enable the craft to reach Pluto at the mission specific time on 14 July 2015. Dynamic Universe Model's predicted data is matching with NH web in that period. The error percentages are 0.2283591%, 0.0093268% & -0.0209431% on the TCM date 2014-Jul-14. These data around this date were shown in BLUE.

It may please be noted the maximum error percentage in predictions went up to 0.239356%, -0.00086751%, & -0.0493872% of NH NASA's web in XYZ coordinates on 2015-Sep-01, the last date for which NH web data is available. This data on this last date from NH web is shown in RED.

Predicted data from the date 2015-Sep-02 to date 1st Jan 2017 from Dynamic Universe Model for 16 more months is given in GREEN. How it matches with the real data will be told by FUTURE only.

In some places some approximate or estimated data for the planets and surrounding stars were used in these calculations. Accuracies will further improve by using more accurate input data. After the first three rows in Table 5, the JPL web address was given. Its actual web outputs for required cases (viz., NH position data for dates 01-Jan-2009; 02-Jan-2009 and for 09-Aug-2009) were also shown later in the Table 5 in its original format for reference.

Dynamic Universe Model can predict further to 09-Aug-2009 without any problem. Any other part of the trajectory data can be calculated.

7. Conclusions- Financial Benefits:

Accurate prediction of trajectory of a satellite is very useful in many ways. We can see clearly by using Dynamic Universe Model for calculating trajectories, the use of thrusters to correct the trajectory will be very much reduced. That means useful payload will increase for the same size of rocket. That means reduction in fuel consumption and reduction in the size of rocket for the same satellite weight. This technique uses…

Dynamic Universe model gives better results compared to just application of GR or two body problem. These results indicate that the structure of our universe is continuously changing dynamically, and depending on Universal Gravitation Force (UGF) on the New Horizons satellite, the trajectory will be varying dependently. The UGF on the NH or any other satellite is based positions and distances of Planets, stars, Galaxies etc., relative to that satellite and varies the dynamically. In addition, it is observed all the point masses follow their own fixed trajectory irrespective of its own mass. That means by changing only value of mass under consideration, the trajectory followed by it will not change by keeping all the other things constant.

Hence, it can be concluded for explaining the trajectory of NH properly, we have to consider gravitation of other planets and masses also instead of just Sun or earth only, and when Dynamic Universe Model used there will be overall financial benefits.

ADVANTAGES: Accurate trajectory planning, reduced usage of thrusters, Increase in useful payload of rocket. Overal project cost reduction, increased reliability of mission.

8. Supplementary Files:

The following files are attached with this paper:

Table 1.xlsx

Table 2.xls

vak NH Table 3 output values.xls

vak NH Table 4 WEB EPHIMERIES.xls

vak NH Table 5 and 6 output positions.xls

Readers are encouraged to visit the on-line version of this paper and find more Appendixes at http://dx.doi.org/10.5539/apr.v7n4p63

9. Future Predictions of NH trajectory by Dynamic Universe Model.

There are three types of future predictions done in this paper.

1) The past predictions done up to today's (20 Aug 2014) date from 3rd Jan 2009. They were matched very nicely, with a maximum error of 0.23150%, 0.00774%, -0.02154% NH NASA's web results in XYZ coordinates.

2) The future predictions done from 20-Aug-2014 to 1st Sept 2015. The New Horizons official web gives data up to this date as on 20 Jul 2014. These were matched nicely. It may please be noted the maximum error percentage in predictions went to a maximum of 0.239356 %, -0.00086751 %, -0.0493872 % of NH NASA's web results in XYZ coordinates

3) The present calculated data from Dynamic Universe Model is given up to 1st Jan 2017, which is 16 months more than available data. Only future can tell how nicely it matches. If a future correction is done by NH administration, the trajectory will change significantly from that point.

Acknowledgements

This work is continuously guided by almighty Vak

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Appendixes

Table 1 Initial values for NH ("Vak NH Table 1.xls")

		Mass (kg)	HELIO CENTRIC ECLIPTIC XYZ VALUES solar sys as on 01.01.2009@00.00:00 hrs in METRE		
		-------	xecliptic	yecliptic	Zecliptic
1	New Horizons Spacecraft	4.78E+02	18319370869	-1.80226E+12	48461397118
2	Mercury	3.30E+23	50644179263	8540296134	-3949485753
3	Venus	4.87E+24	69657878862	82614198079	-2889306238
4	Earth	5.97E+24	-29565785818	1.44096E+11	-2869446.398
5	Mars	6.42E+23	-3275068912	-2.17902E+11	-4484946284
6	Jupiter	1.90E+27	4.09177E+11	-6.46362E+11	-6473185584
7	Saturn	5.68E+26	-1.35874E+12	3.39522E+11	48167461412
8	Uranus	8.68E+25	2.97521E+12	-4.32376E+11	-40141525477
9	Neptune	1.02E+26	3.61461E+12	-2.66852E+12	-28350290138
10	Pluto	1.27E+22	69315882273	-4.69858E+12	4.82751E+11

11	Moon	7.35E+22	-29191657344	1.43975E+11	16609650.17
12	SUN	1.99E+30	0	0	0
13	near star	3.97658E+29	-3.07379E+16	-2.48085E+16	5.99014E+15
14	near star	1.88888E+30	-1.70141E+16	-4.49612E+13	3.79378E+16
15	near star	2.18712E+30	-1.71774E+16	-1.53305E+14	3.78638E+16
16	near star	7.95317E+29	-1.85801E+15	1.6393E+15	-5.61485E+16
17	near star	8.94731E+29	9.02924E+15	-7.13182E+15	-7.77879E+16
18	near star	1.73976E+31	-3.1682E+16	-2.99664E+16	6.86968E+16
19	near star	8.94731E+29	2.37665E+16	-7.07555E+15	8.82862E+16
20	near star	1.88888E+30	9.77757E+16	-1.69837E+16	3.32855E+15
21	near star	8.94731E+29	-1.75629E+16	-2.0874E+16	9.78004E+16
22	near star	3.97658E+29	3.82107E+16	6.00795E+16	7.44241E+16
23	near star	1.82923E+30	-4.50486E+16	3.01003E+16	9.28066E+16
24	near star	3.28068E+30	-8.42312E+15	5.24915E+16	-9.39112E+16
25	near star	1.19298E+30	-4.60396E+16	3.03873E+16	9.29744E+16
26	near star	7.95317E+29	4.90495E+16	9.64605E+16	7.35909E+15
27	near star	8.94731E+29	4.99158E+16	9.78689E+16	7.06783E+15
28	near star	7.95317E+29	-1.39114E+16	-1.09124E+17	4.36506E+15
29	near star	1.82923E+30	-6.28738E+16	-8.89396E+16	-2.56335E+16
30	near star	2.18712E+30	-6.90623E+16	-8.50246E+16	2.58319E+16
31	near star	3.97658E+29	-2.35768E+16	2.08864E+16	1.10275E+17
32	near star	7.95317E+29	1.86257E+16	-5.54342E+16	-1.01576E+17
33	near star	8.94731E+29	-5.04468E+16	3.78032E+16	-1.03142E+17
34	near star	1.19298E+30	2.09805E+16	-4.31965E+16	-1.11915E+17
35	near star	5.96488E+29	-3.34107E+16	-3.81344E+16	1.12791E+17
36	near star	5.96488E+29	1.20105E+17	-5.23499E+15	-4.10595E+16
37	near star	8.94731E+29	-5.81398E+16	4.54439E+16	-1.08443E+17
38	near star	6.95902E+29	-1.07352E+17	7.50846E+16	-1.2264E+16
39	near star	9.94146E+29	2.96095E+16	1.22996E+17	4.58116E+16
40	near star	2.90291E+30	8.24904E+16	-2.35538E+16	-1.05478E+17
41	near star	8.94731E+29	-6.10305E+16	4.80435E+16	-1.15415E+17
42	near star	8.94731E+29	9.76996E+16	2.14625E+16	-9.75422E+16
43	near star	7.95317E+29	2.15194E+16	1.34558E+17	-3.20268E+16
44	near star	5.64675E+30	-5.35209E+16	-2.81642E+16	-1.29127E+17
45	near star	6.95902E+29	1.14625E+16	1.39712E+16	-1.43945E+17
46	near star	8.94731E+29	-1.32781E+17	1.60851E+16	-6.59031E+16
47	near star	1.19298E+30	-4.78813E+16	9.19484E+16	-1.08903E+17
48	near star	1.65028E+30	1.04974E+16	-1.34655E+17	-7.02332E+16
49	near star	8.94731E+29	-4.59519E+16	8.94752E+15	1.44982E+17
50	near star	5.96488E+29	1.36804E+17	5.36738E+16	-5.10992E+16
51	near star	2.00817E+30	1.77107E+16	2.7082E+16	-1.52249E+17
52	near star	8.94731E+29	-1.0952E+17	9.68318E+16	5.3829E+16
53	near star	1.88888E+30	-4.72306E+16	-1.16764E+17	9.36129E+16
54	near star	5.09003E+30	9.79121E+16	-9.2465E+16	8.39443E+16
55	near star	3.97658E+29	1.09829E+17	9.70466E+16	6.62157E+16
56	near star	7.95317E+29	-9.10748E+16	-1.36971E+17	-2.48893E+16
57	near star	1.09356E+30	-7.0043E+16	9.14497E+16	1.2171E+17
58	near star	5.96488E+29	-2.64948E+16	4.32255E+16	1.61635E+17

59	near star	1.49122E+30	-3.16721E+16	1.25283E+17	1.1067E+17
60	near star	7.95317E+29	4.73982E+16	1.59067E+15	1.63433E+17
61	near star	5.96488E+29	1.20195E+17	-9.0224E+16	8.74395E+16
62	near star	8.94731E+29	-5.75703E+16	-1.4009E+17	8.88539E+16
63	near star	7.95317E+29	6.76572E+16	-4.60048E+16	-1.57068E+17
64	near star	2.12747E+30	-9.2162E+16	-1.20447E+17	9.30606E+16
65	near star	8.94731E+29	5.72296E+15	1.76608E+17	-2.27853E+16
66	near star	5.96488E+29	-1.34996E+17	-1.16182E+17	-1.30636E+16
67	near star	5.96488E+29	-1.19512E+17	4.88067E+16	-1.2445E+17
68	near star	9.94146E+29	7.87302E+16	1.638E+16	-1.62411E+17
69	near star	1.82923E+30	3.91777E+16	1.47326E+17	-9.98492E+16
70	near star	6.95902E+29	1.67294E+17	-1.18466E+16	-7.32836E+16
71	near star	8.94731E+29	-1.39077E+17	-9.10857E+16	7.67253E+16
72	near star	2.78361E+30	5.24234E+16	-1.59364E+16	1.75315E+17
73	near star	1.65028E+30	3.6434E+15	2.91335E+16	-1.81794E+17
74	near star	9.94146E+29	-9.07771E+16	1.01639E+17	1.23937E+17
75	near star	1.88888E+30	6.41076E+15	1.79687E+16	-1.83691E+17
76	near star	1.88888E+30	-2.06314E+15	-5.39393E+15	1.86646E+17
77	near star	2.18712E+30	1.0974E+17	-3.31921E+16	1.4771E+17
78	near star	2.18712E+30	-1.54154E+17	-1.01333E+17	3.85252E+16
79	near star	5.96488E+29	4.30221E+16	-1.83542E+17	8.55871E+15
80	near star	9.94146E+29	-1.30645E+17	6.84493E+16	-1.20949E+17
81	near star	1.09356E+30	-1.31276E+17	6.75268E+16	-1.20784E+17
82	near star	1.19298E+30	-1.33898E+17	-5.20951E+16	1.2578E+17
83	near star	1.09356E+30	-2.19059E+16	6.93128E+16	-1.77114E+17
84	near star	1.49122E+30	3.99999E+16	8.00904E+16	1.70731E+17
85	near star	6.95902E+29	-2.19758E+16	-1.28321E+16	-1.9175E+17
86	near star	1.09356E+30	-1.3524E+17	-5.38681E+16	1.27447E+17
87	near star	8.94731E+29	-2.07383E+16	-9.28974E+15	1.93754E+17
88	near star	5.96488E+29	1.01434E+17	8.45481E+16	1.45159E+17
89	near star	5.96488E+29	7.37726E+16	-5.17702E+16	-1.79009E+17
90	near star	1.82923E+30	-1.50711E+17	6.46728E+16	1.16827E+17
91	near star	6.95902E+29	-3.30768E+16	-1.22256E+17	-1.58766E+17
92	Glob Clus Group	1.20578E+37	-1.16925E+21	-1.04245E+21	9.31497E+19
93	Glob Clus Group	7.43305E+36	-1.79414E+20	-3.61781E+20	-1.42253E+19
94	Glob Clus Group	9.58802E+36	1.48744E+19	2.77665E+19	-7.91706E+19
95	Glob Clus Group	7.05555E+36	6.94375E+19	-4.44352E+18	7.944E+17
96	Glob Clus Group	6.46631E+36	9.11252E+19	-4.39257E+19	1.89032E+20
97	Glob Clus Group	7.23385E+36	1.05314E+20	2.06504E+19	8.97721E+19
98	Glob Clus Group	6.79923E+36	1.25702E+20	6.15542E+19	3.76993E+19
99	Glob Clus Group	8.07244E+36	1.5288E+20	2.40773E+19	-1.58338E+19
100	Glob Clus Group	9.57827E+36	1.74887E+20	1.35743E+19	-3.13919E+19
101	Glob Clus Group	8.2981E+36	1.85602E+20	5.87126E+19	1.50955E+19
102	Glob Clus Group	1.03904E+37	2.00762E+20	1.02368E+20	7.89348E+19
103	Glob Clus Group	8.99599E+36	2.21232E+20	1.03194E+19	-1.15685E+20
104	Glob Clus Group	8.5572E+36	2.40926E+20	2.38732E+19	8.08095E+18
105	Glob Clus Group	9.81786E+36	2.52521E+20	-1.04214E+19	-1.90968E+18
106	Glob Clus Group	9.86105E+36	2.63724E+20	1.58631E+19	2.36248E+19

107	Glob Clus Group	8.93192E+36	2.80244E+20	4.57404E+18	-5.62166E+18
108	Glob Clus Group	1.00965E+37	2.93615E+20	-2.52379E+19	6.36066E+18
109	Glob Clus Group	1.37127E+37	3.13834E+20	-1.18077E+18	1.46617E+19
110	Glob Clus Group	1.01466E+37	3.35306E+20	-1.68075E+20	-3.47826E+19
111	Glob Clus Group	1.11914E+37	3.72364E+20	1.37362E+19	-1.25647E+20
112	Glob Clus Group	1.02218E+37	4.87315E+20	1.74393E+20	8.66073E+19
113	Glob Clus Group	9.30663E+36	6.49171E+20	1.82615E+18	9.06719E+19
114	Glob Clus Group	9.89727E+36	1.0232E+21	1.53107E+20	4.80442E+20
115	Galaxy center	7.164E+36	4.79211E+19	1.67483E+20	1.56991E+20
116	Milkyway part	3.84731E+40	-1.63642E+20	1.47838E+20	-7.97417E+19
117	Milkyway part	4.80914E+40	1.54517E+20	8.22578E+19	1.56049E+20
118	Milkyway part	5.77096E+40	-1.14673E+19	4.68166E+19	2.29499E+20
119	Milkyway part	6.73279E+40	-8.86592E+19	-1.0611E+19	2.16841E+20
120	Milkyway part	7.69462E+40	5.62463E+19	-1.61296E+20	-1.60665E+20
121	Milkyway part	8.65645E+40	-1.1565E+20	2.03896E+20	6.68227E+18
122	Milkyway part	9.61827E+40	-3.63423E+19	1.12347E+19	-2.31401E+20
123	Milkyway part	1.05801E+41	-1.72238E+20	-7.67886E+19	1.39394E+20
124	Milkyway part	1.05801E+41	-2.05075E+19	-2.19577E+20	7.97417E+19
125	Milkyway part	9.61827E+40	-1.58373E+20	7.45639E+19	-1.56049E+20
126	Milkyway part	8.65645E+40	-3.06445E+19	-3.72049E+19	-2.29499E+20
127	Milkyway part	7.69462E+40	6.156E+19	-6.46792E+19	-2.16841E+20
128	Milkyway part	6.73279E+40	9.55613E+19	1.41591E+20	1.60665E+20
129	Milkyway part	5.77096E+40	2.32564E+20	-2.93704E+19	-6.68227E+18
130	Milkyway part	4.80914E+40	3.07501E+19	2.23922E+19	2.31401E+20
131	Milkyway part	3.84731E+40	4.15581E+19	1.83944E+20	-1.39394E+20
132	Andromeda	1.4129E+42	1.74266E+22	1.50487E+22	6.79254E+21
133	Triangulum Galaxy	1.41E+41	1.28546E+20	1.93083E+22	-1.82029E+22