

# New Universal Gravity and Rational Galaxy Structure

by

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**Abstract** New Universal Gravity: To any point on a rational structure, there correspond three proportion surfaces which pass the point and are orthogonal to each other. To any proportion surface there exists the corresponding component of the gravitational force at the point whose direction is normal to the surface (pointing to the larger matter density) and whose magnitude is proportional to the Gaussian curvature of the surface at the point and proportional to the total mass contained in the surface. The new universal gravity is promising in that it generalizes Newtonian gravity and gives a unified explanation to both discrete and smooth natural structures (i.e., Solar system and galaxies).

keywords: Spiral Galaxy, Rotational Curve, Rational Structure, Newtonian Gravity

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## 1 Introduction

Longer wavelength galaxy images reveal that galaxies are smooth, continuous structures. We humans live in such a spiral galaxy called the Milky Way. However, the immediate environment of human life is not smooth or continuous. The Solar system which is a discrete structure, is composed of the Sun, eight planets, and other small objects. Newtonian universal gravity is a theory which describes the orbital motion of such discrete structures. The theory fails when applied to the study on galaxy structure and dynamics [1]. The purpose of this article is to generalize Newtonian universal gravity so that it is applicable to both discrete and smooth structures. It is called New Universal Gravity. If proven, it would be one of the most important scientific progresses.

## 2 Jin He's Rational Galaxy Structure

Much observational evidence has been found which supports Jin He's concept of rational galaxy structure. A planar rational structure is defined as follows

**Rational Structure:** In the plane of two dimensional distribution of matter, there exists an orthogonal net of curves. For each curve, the ratio of matter densities from the two sides of the curve is constant along the curve. Such a curve is called a proportion curve or a Darwin curve. Such a distribution of matter is called a rational structure.

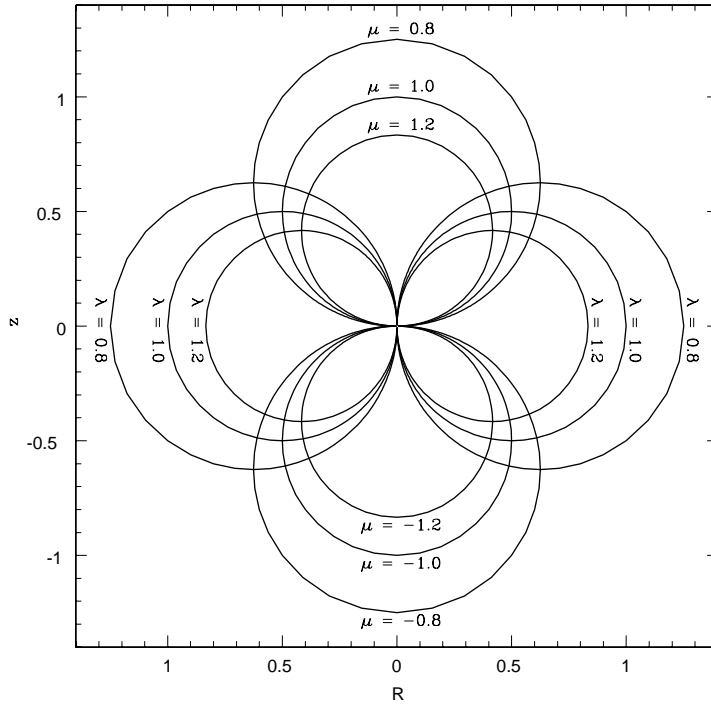


Figure 1: A planar section of the proportion spheres of rational elliptical galaxy structure. Depending on the assumption of axi-symmetric shape or triaxial shape, an elliptical galaxy has either an orthogonal net of 4-spheres or an orthogonal net of 6-spheres. The graph is taken from the reference [3].

Spiral galaxies are planar distribution of stars. There are two kinds of spiral galaxies. The spiral galaxy with a barred pattern is called a barred spiral. The spiral galaxy without a barred pattern is called an ordinary spiral. The stellar distribution of an ordinary spiral galaxy is axi-symmetric with respect to the galaxy center, and its stellar density decreases exponentially in the radial direction. Therefore, it is called the exponential disk. Certainly the exponential disk is a rational structure. Any orthogonal net of proportion curves of an exponential disk is composed of golden spirals. However, there is the trivial net of proportion curves which is composed of all concentric circles centered at the galaxy center and all radial lines. As we know, spiral galaxies have a definite thickness and can be considered a three-dimensional structure. Astronomers observed that all straight vertical lines perpendicular to the galaxy disk are proportion curves too [2]. Therefore, when an ordinary spiral galaxy is considered to be a three-dimensional structure, these concentric proportion circles become coaxial proportion cylinders and the radial lines becomes coaxial radial planes. That is, the orthogonal net of proportion surfaces of ordinary spiral galaxies is composed of all coaxial cylinders and coaxial planes which are perpendicular to the galaxy disk, and all planes which are parallel to the galaxy disk.

In the universe, there is a third kind of galaxies which are called ellipticals. Jin He has proved that elliptical galaxies are a rational structure too [3]. Their orthogonal net of proportion surfaces is composed of all spheres (see Figure 1).

In conclusion, relatively independent smooth structures in the universe are unique. They are either ellipticals or spirals. Dr. Jin He proved that all galaxies are rational structures. Amazingly, the basic proportion surfaces are either planes, cylinders, or spheres. Therefore, if we find the geometric meaning behind Newtonian universal gravity,

we may generalize it and use it to explain the gravitational dynamics of galaxy structure. This is discussed in the next Sections.

### 3 New Universal Gravity

**New Universal Gravity:** To any point on a rational structure, there correspond three proportion surfaces which pass the point and are orthogonal to each other. To any proportion surface there exists the corresponding component of the gravitational force at the point whose direction is normal to the surface (pointing to the larger matter density) and whose magnitude is proportional to the Gaussian curvature of the surface at the point and proportional to the total mass contained in the surface.

If it is a cosmic truth, the new universal gravity would be one of the most important scientific progresses. First, let us prove that the new universal gravity is the generalization of Newtonian universal gravity. Newtonian universal gravity is not about smooth structure. For example, when applied to the Solar system, the Sun is considered to be a point mass. However, if we imagine the Sun as a larger spherically-symmetric ball whose radius reached the earth and whose total mass did not change, the orbit of the earth around the Sun would not change at all. In fact, the motion of all outer planets would not change either. We use  $r$  to denote the distance between the center of the Sun and the center of the earth. The mass distribution of the giant Sun would be a rational structure whose proportion sphere at the point of the earth would have the radius  $r$ . Now, we apply the new universal gravity to the giant Sun. Then the Gaussian curvature of the sphere is  $1/r^2$ . According to the new universal gravity, the gravitational force at the point of earth due to the Sun is proportional to the curvature. That is, the gravitational force is inversely proportional to the squared radius  $r$ . The new gravity is also proportional to the mass contained in the sphere that is the mass of the Sun,  $M$ . Therefore, the new gravity is

$$f \sim \frac{M}{r^2} \quad (1)$$

Here we see that it is equivalent to the Newtonian universal gravity. Therefore, our new universal gravity is the generalization of the Newtonian universal gravity.

### 4 Preliminary Galaxy Application and Constant Rotational Curves

Firstly let us study spiral galaxies. The mass distribution of an ordinary spiral galaxy is an exponential disk. Considered to be three dimensional, it is still rational structure (see the above Section 2). Its proportion surfaces are coaxial cylinders, coaxial planes, and parallel planes. Because the Gaussian curvature of any plane is zero, the corresponding component of the gravitational force is zero. We need consider the gravitational force corresponding to the cylinders. The normal directions to the cylinders are all radial lines starting at the axis which passes the galaxy center and is perpendicular to the galaxy disk. Therefore, the gravitational field of spiral galaxies is two dimensional, which is parallel

to the galaxy disk. Because the curvature of the circle of radius  $r$  is  $1/r$  and the new gravitational force is proportional to the curvature, the force is inversely proportional to the radius  $r$

$$f \sim \frac{1}{r} \quad (2)$$

Now we suppose a star rotates circularly at the radius  $r$ . Its acceleration is  $v^2/r$ . Therefore,

$$\frac{v^2}{r} \sim \frac{1}{r} \quad (3)$$

Finally, we proved the constant rotational curves of ordinary spiral galaxies [2],

$$v = \text{constant} \quad (4)$$

The mass distribution of barred spiral galaxies is mainly an exponential disk too. According to Dr. Jin He's study, double-breast structures are attached to the disk to make a bar-shaped pattern. Therefore, cylinders are no longer their proportion surfaces. But new universal gravity is still applicable to the barred pattern and the conclusion of constant rotational curves is still true. However, traditional galaxy study keeps Newtonian universal gravity and adds unobservable dark halo to maintain constant rotational curves.

Although elliptical galaxies are three dimensional, they pose missing matter problems too. According to Dr. Jin He's study, elliptical galaxies are rational too. Their proportion surfaces are spheres (see Figure 1). Let us study the triaxial model of elliptical galaxies. According to new universal gravity, the three components of the gravity are in the normal directions to the orthogonal net of 6-spheres. This may pose larger gravity than the Newtonian theory and resolve the missing matter problems. This deserves further investigation.

## 5 Discussion

New universal gravity is promising in that it generalizes Newtonian gravity and gives a unified explanation to both discrete and smooth natural structures (i.e., Solar system and galaxies). Note that our new gravitational law is based on the proportion surfaces of rational structure. Because rational structure is harmonically unique and its examples are extremely limited, the involved proportion surfaces are not mathematically arbitrary. They root in the natural beauty. We look forward to deep investigation of our new universal gravity.

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