The Creator's Quest for Humans

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Abstract According to Western religion, galaxies are designed by the Creator. Dr. Jin He found many evidences that galaxies are rational distribution of stars. Rational structure in two dimension means that not only there exists an orthogonal net of curves in the plane but also, for each curve, the stellar density on one side of the curve is in constant ratio to the density on the other side of the curve. Such a curve is called a proportion curve or a Darwin curve. Such a distribution of matter is called a rational structure. There are plenty of evidences for rational galaxy structure. We list a few examples. Firstly, galaxy stellar distribution can be fitted to rational structure. Secondly, spiral arms can be fitted to Darwin curves. Thirdly, rational structure dictates New Universal Gravity which explains constant rotation curves elegantly. However, there has been no systematic study on rational structure. This letter presents a general partial differential equation whose solution must be rational structure. Also given in the letter is the geometric meaning of the equation. The general solution to the equation is called the Creator's open quest for humans which has not been answered yet.

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1 Rational Structure

This letter focuses on the study of two dimensional rational structure. The matter density distribution is ρ. But we are only concerned with the logarithmic density,

$$f(x, y) = \ln \rho(x, y) \tag{1}$$

where x, y are the rectangular Cartesian coordinates in the plane. The following two functions on the (λ, μ) plane,

$$x = x(\lambda, \mu),\ y = y(\lambda, \mu) \tag{2}$$

describe a net of curves on the (x, y) plane. Letting the second parameter μ be a constant, we have a curve called a row curve. That is, the above formula is a curve with its parameter being λ. For the different values of the constant μ, we have a set of "parallel" rows. Similarly, we have a set of "parallel" columns of parameter μ. However, The row curves and the column curves are not necessarily orthogonal to each other. The following equation is the necessary and sufficient condition for the net of curves to be orthogonal,

$$\frac{\partial x}{\partial \lambda}\frac{\partial x}{\partial \mu} + \frac{\partial y}{\partial \lambda}\frac{\partial y}{\partial \mu} \equiv 0. \tag{3}$$

We know that, given the two partial derivatives,

$$\frac{\partial f}{\partial x}, \quad \frac{\partial f}{\partial y} \tag{4}$$

the structure $f(x, y)$ is determined provided that the Green's theorem is satisfied

$$\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}. \tag{5}$$

Now we are interested in rational structure and ignore the partial derivatives (4). Instead, we calculate the directional derivatives along the tangent direction to the above curves (2),

$$\frac{\partial f}{\partial l_\lambda}, \quad \frac{\partial f}{\partial l_\mu} \tag{6}$$

where l_λ is the linear length on the (x, y) plane and along the row curves while l_μ is the linear length along the column curves. Given the two partial derivatives (6), however, the structure $f(x, y)$ may not be determined. A similar Green's theorem must be satisfied,

$$\frac{\partial}{\partial \mu}\left(P\,\frac{\partial f}{\partial l_\lambda}\right) - \frac{\partial}{\partial \lambda}\left(Q\,\frac{\partial f}{\partial l_\mu}\right) = 0 \tag{7}$$

where

$$P = \sqrt{x_\lambda'^2 + y_\lambda'^2}, \quad Q = \sqrt{x_\mu'^2 + y_\mu'^2} \tag{8}$$

are the lengths or magnitudes of the vectors (x'_λ, y'_λ) and (x'_μ, y'_μ) on the (x, y) plane, respectively. Note that we have used the simple notation $x'_\lambda = \frac{\partial x}{\partial \lambda}$. From now on, we always use the similar simple notation. To simplify the expression of our equations, we introduce one more notation,

$$u(\lambda, \mu) = \frac{\partial f}{\partial l_\lambda}, \quad v(\lambda, \mu) = \frac{\partial f}{\partial l_\mu}. \tag{9}$$

As you might know, the above notation is very useful. However, my articles on rational structure which employ the notations were rejected hundreds of times by the editors of over fifty scientific journals. I am afraid that the editors could not understand the notation at all.

The condition of rational structure is that u depends only on λ and v depends only on μ,

$$u = u(\lambda), \ v = v(\mu). \tag{10}$$

Now we prove the condition. Assume you walk along a row curve. The logarithmic ratio of the density on your left side to the immediate density on your right side is approximately the directional derivative of $f(x, y)$ along the column direction. That is, the logarithmic ratio is approximately the directional derivative $v(\lambda, \mu)$. Because $v(\lambda, \mu)$ is constant along the row curve (rational), $v(\lambda, \mu)$ is independent of λ: $v = v(\mu)$. Similarly, we can prove that $u(\lambda, \mu) = u(\lambda)$.

2 Rational Structure Equation

In the case of rational structure, the directional derivatives, $u = \frac{\partial f}{\partial l_\lambda}$ and $v = \frac{\partial f}{\partial l_\mu}$, are the functions of the single variables λ and μ, respectively (see the formula (10)). Therefore, the Green's theorem (7) turns out to be much simpler that is called the rational structure equation,

$$u(\lambda)P'_\mu = v(\mu)Q'_\lambda \tag{11}$$

To transform the equation and find its geometric meaning, we calculate,

$$\begin{aligned} P'_\mu &= (x'_\lambda x''_{\lambda\mu} + y'_\lambda y''_{\lambda\mu})/P, \\ Q'_\lambda &= (x'_\mu x''_{\lambda\mu} + y'_\mu y''_{\lambda\mu})/Q \end{aligned} \tag{12}$$

That is,

$$\begin{aligned} P'_\mu &= \hat{\mathbf{x}}'_\lambda \cdot \mathbf{x}''_{\lambda\mu}, \\ Q'_\lambda &= \hat{\mathbf{x}}'_\mu \cdot \mathbf{x}''_{\lambda\mu} \end{aligned} \tag{13}$$

where boldface letters are the notations of vectors,

$$\mathbf{x} = (x, y), \quad \mathbf{x}'_\lambda = (x'_\lambda, y'_\lambda), \quad \mathbf{x}''_{\lambda\mu} = (x''_{\lambda\mu}, y''_{\lambda\mu}), \quad \text{etc.} \tag{14}$$

The hats above letters mean that the corresponding vectors are unit ones. The dot symbol is the inner product of vectors. The geometric meaning of the formula (13) is that P'_μ is the projection of the vector $\mathbf{x}''_{\lambda\mu}$ in the direction of the vector $\mathbf{x}'_\lambda$ and Q'_λ is the projection of the same vector in the direction of the vector $\mathbf{x}'_\mu$. They are also the geometric meaning of our final rational structure equation (21) or (22).

Finally, our rational structure equation becomes

$$u(\lambda)\hat{\mathbf{x}}'_\lambda \cdot \hat{\mathbf{x}}''_{\lambda\mu} = v(\mu)\hat{\mathbf{x}}'_\mu \cdot \hat{\mathbf{x}}''_{\lambda\mu} \tag{15}$$

However, the solution $f(x, y)$ of the equation may not be rational structure because the net of curves may not be orthogonal. The solution of the following equation system must be rational

$$\begin{cases} u(\lambda)\hat{\mathbf{x}}'_\lambda \cdot \hat{\mathbf{x}}''_{\lambda\mu} = v(\mu)\hat{\mathbf{x}}'_\mu \cdot \hat{\mathbf{x}}''_{\lambda\mu}, \\ \mathbf{x}'_\lambda \cdot \mathbf{x}'_\mu = 0 \end{cases} \tag{16}$$

where the second equation is the orthogonal condition (3).

The rational structure equation can be further simplified. Because of the orthogonal condition, we have

$$(\hat{\mathbf{x}}'_\lambda \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 + (\hat{\mathbf{x}}'_\mu \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 = 1. \tag{17}$$

We denote $(\hat{\mathbf{x}}'_\lambda \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2$ by $\cos^2\theta$, and we have

$$\begin{aligned} (\hat{\mathbf{x}}'_\lambda \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 &= \cos^2\theta, \\ (\hat{\mathbf{x}}'_\mu \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 &= 1 - \cos^2\theta \end{aligned} \tag{18}$$

The first equation in (16) is squared and becomes

$$u^2(\lambda)\cos^2\theta = v^2(\mu)(1 - \cos^2\theta). \tag{19}$$

Solving for $\cos^2\theta$, we have

$$\cos^2\theta = \frac{v^2(\mu)}{u^2(\lambda)+v^2(\mu)}. \tag{20}$$

Finally, our general partial differential equation for rational structure is

$$\begin{cases} (\hat{\mathbf{x}}'_\lambda \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 = \frac{v^2(\mu)}{u^2(\lambda)+v^2(\mu)}, \\ \mathbf{x}'_\lambda \cdot \mathbf{x}'_\mu = 0 \end{cases} \tag{21}$$

or equivalently

$$\begin{cases} (\hat{\mathbf{x}}'_\mu \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 = \frac{u^2(\lambda)}{u^2(\lambda)+v^2(\mu)}, \\ \mathbf{x}'_\lambda \cdot \mathbf{x}'_\mu = 0 \end{cases} \tag{22}$$

3 Cauchy–Riemann Equations

If we require the two functions $x(\lambda,\mu)$ and $y(\lambda,\mu)$ (see (2)) satisfy Cauchy-Riemann equations,

$$\begin{aligned} x'_\lambda &= y'_\mu, \\ x'_\mu &= -y'_\lambda \end{aligned} \tag{23}$$

then the orthogonal condition is naturally satisfied, and the general equation for rational structure becomes

$$(\hat{\mathbf{x}}'_\lambda \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 = \frac{v^2(\mu)}{u^2(\lambda)+v^2(\mu)} \tag{24}$$

or equivalently

$$(\hat{\mathbf{x}}'_\mu \cdot \hat{\mathbf{x}}''_{\lambda\mu})^2 = \frac{u^2(\lambda)}{u^2(\lambda)+v^2(\mu)}. \tag{25}$$

Furthermore, if the partial derivatives, $x'_\lambda, x'_\mu, y'_\lambda, y'_\mu$, are all continuous functions on an area of the (λ,μ) plane then the complex function

$$z = x + i\,y \tag{26}$$

is an analytic function of the variable

$$\tau = \lambda + i\,\mu \tag{27}$$

on the same area. These are true for some galaxy structure.

4 Galaxy Application

If we ignore those strongly interacting galaxies or some extremely small galaxies, there exist only two types of galaxies: spiral galaxies and elliptical galaxies. There are two kinds of spiral galaxies. A spiral galaxy with a bar is called a barred spiral, and a spiral galaxy without a bar is called an ordinary spiral. Astronomers found out that the stellar density distribution of ordinary spiral galaxies is basically an axi-symmetric disk described by the formula,

$$\rho(x,y) = d_0 \exp(d_1 r) \tag{28}$$

where d_0 and d_1 are constants. It is called the exponential disk. Its corresponding logarithmic stellar distribution is,

$$f(x,y) = d_1 r \tag{29}$$

Its corresponding solution to the equation (24) is

$$z = \exp(c\tau) \tag{30}$$

where c is a constant.

Astronomers have found out that the main structure of barred spiral galaxies is also the exponential disk. Therefore, we subtract the fitted exponential disk from a barred spiral galaxy image. What is left over? Jin He discovered that the left-over resembles human breasts [1,2]. Jin He calls it double-breast structure. Barred spiral galaxies, however, have more than a pair of breasts. The bar of barred spiral galaxies is composed of two or three pairs of breasts which are usually aligned. The addition of the two or three pairs of breasts to the major structure of exponential disk becomes a bar-shaped pattern which crosses galaxy center. Double-breast structure is also a rational structure. Its density distribution is [3],

$$\rho(x,y) = b_0 \exp\left((b_2/3) \left((r^2 - b_1^2)^2 + 4b_1^2 x^2 \right)^{3/4} \right) \tag{31}$$

where b_0, b_1, b_2 are constants. Its corresponding logarithmic stellar distribution is,

$$f(x,y) = (b_2/3) \left((r^2 - b_1^2)^2 + 4b_1^2 x^2 \right)^{3/4} \tag{32}$$

Its corresponding solution to the equation (24) is

$$z = c\,\mathrm{ch}(\tau) \tag{33}$$

where c is a constant.

The stellar distribution of elliptical galaxies is based on the following solution to the equation (24)

$$z = 1/\tau \tag{34}$$

Its density distribution is [4]

$$\rho(x,y) = \rho_0 \left(\frac{1}{x^2 + y^2} \right)^{h/2} \tag{35}$$

where ρ_0, h are constants. Its corresponding logarithmic stellar distribution is,

$$f(x,y) = (h/2) \ln \frac{1}{x^2 + y^2} \tag{36}$$

5 Discussion

There are plenty of evidences for rational galaxy structure. We list a few examples. Firstly, galaxy stellar distribution can be fitted to rational structure. Secondly, spiral arms can be fitted to Darwin curves [5]. Thirdly, rational structure dictates New Universal Gravity which explains constant rotation curves elegantly [6]. However, there has been no systematic study on rational structure. This letter presents a general partial differential equation whose solution must be rational structure. Also given in the letter is the geometric meaning of the equation. The general solution to the equation is called the Creator's open quest for humans which has not been answered yet.

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