On the space-time structure of the Milky Way

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Abstract: *This article uses a new space-time model to analyze the space-time distribution of the Milky Way. The new space-time model can better explain the three-layer structure of the Milky Way. These three-layer structures are the kernel, the bulge and the disc. The analysis results show that the gravitational force of the galactic kernel's substance can act on all the masses in it. The gravitational force generated by the bulge's substance can only cover most of the masses in it, but the substance at the edge of the bulge cannot be covered. The density of matter on the disc is very low, which causes the galaxies in the low-density regions of the MW disc to basically move freely. The galaxies on the spiral arms will have a strong gravitational interaction. However, the new model has to explain why many galaxies can still maintain a disc-like structure when many galaxies are in free motion, and may need to use the concept of dark matter.*

1 Introduction

For the origin of spacetime, there are few papers involved. I have analyzed the electrostatic energy carried by elementary particles during this period and found that this energy is ignored in various standard physical models. If we regard this kind of electrostatic energy as the same thing as the mass, we can find that the electrostatic energy distribution range of the substance far exceeds the corresponding mass distribution range. With the existence of such a large range of energy distribution, the only physical quantity that can correspond is spacetime. In this way, a brand new model of spacetime was established. If this new model of spacetime structure is applied to the structure of galaxies, we can find that the spacetime structure formed by galaxy matter is limited. And the limited space-time coverage may mean the limited scope of gravity.

The spacetime structure of the solar system can basically cover the entire solar system, so it can be analyzed with the help of Newtonian mechanics or general relativity. The solar system can form a fixed orbit around the sun.

Judging from the analysis results of the paper [1], the spacetime structure of the solar system has a radius of approximately 10^{14}m. This spacetime coverage can also be confirmed from the data analysis of Mercury's perihelion precession [2].

However, when this model is applied to the Milky Way, it can be found that the spacetime structure of all the matter in the Milky Way is much smaller than the radius of the Milky Way. This means that the spacetime structure formed by the Milky Way's matter cannot cover the entire Milky Way. So what is the reason for maintaining the structure of the Milky Way? This is a question worthy of in-depth discussion. Perhaps dark matter is indeed needed for restraint. Due to the limited scope of gravity, it means that the structure of matter in the Milky Way is more similar to fluid. Of course, the range of space-time distribution does not mean that the range of gravity will be limited by this range of space-time. If there is dark matter, perhaps dark matter can also become a medium for gravitational transmission.

2 Estimation of the range of space-time structure formed by various parts of the Milky Way

For the kernel of the Milky Way, the current estimate of its mass is about 2 million suns. Therefore, the radius of the solar system's spacetime structure is about 10^{14}m as the standard, and then it can be estimated from the formula in [1]

$$R_{MWK} = \sqrt[3]{kM_{MWK}}r_c = \sqrt[3]{\frac{M_{MWK}}{M_{sun}}}\sqrt[3]{kM_{sun}}r_c \approx \sqrt[3]{2 \times 10^6} \times 10^{14}m \approx 1.4 \times 10^{17}m$$

That is, it covers about 14 light years. This part of the substance should be able to maintain a complete spherical shape.

If estimated according to the bulge of the Milky Way, this part has about 15% of the mass of the Milky Way. If we consider that the total mass of the Milky Way is about $1.5 \times 10^{12}m_{\odot}$

It can be estimated that the space-time coverage of this part is approximately

$$R_{MWC} \approx \sqrt[3]{0.15 \times 1.5 \times 10^{12}} \times 10^{14}m \approx 4.7 \times 10^{19}m$$

The space-time coverage is approximately 4700 light-years. The lateral diameter of this part observed so far is about 20,000 light-years, and the height of the bulge is about 10,000 light-years. It can be seen that this calculated value is basically the same as the bulge height of the center of the Milky Way.

For the entire Milky Way, the distribution range of the space-time structure that can be formed by the total mass of the Milky Way can be calculated：

$$R_{MW} \approx \sqrt[3]{1.5 \times 10^{12}} \times 10^{14}m \approx 1.2 \times 10^{20}m$$

It can be seen that if all the matter in the Milky Way is gathered together, the radius of the space-time structure formed will only be 12,000 light years.

The radius of the entire Milky Way as we know it now reaches more than 100,000 light years. Therefore, the distribution of matter in the Milky Way has far exceeded the scope of the space-time structure formed by the total mass of the Milky Way. This also means that these stars outside of the MW bugle can no longer move in a closed elliptical orbit according to Newton's law or the principle of general relativity like in a galaxy like the solar system.

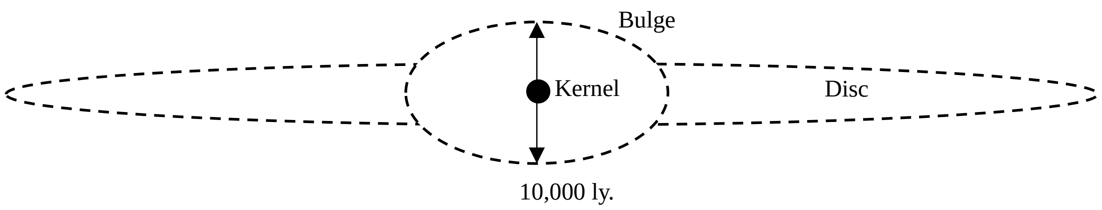

Figure 1. The spacetime structure of Milky Way

Figure 1 shows three layer space-time structures of the Milky Way. The innermost core is the kernel of the Milky Way, which has a mass of about 2 million solar masses and a radius of about 1 light-year. The kernel of the Milky Way is a complete spherical structure. After leaving the kernel, matter began to appear discretely distributed. The range of mass distribution has exceeded the range of spacetime structure formed by these substances. The mass of this part is about 1.5 trillian solar masses, the radius is about 10,000 light years, and the height of the bulge is about 10,000 light years. At the periphery of the Milky Way, the mass distribution is far beyond the space-time structure formed by these substances, so these masses form a flat distribution in the direction that they were initially ejected from the center of the Milky Way. However, because the distribution of matter is very discrete, the scope of the space-time structure formed by local matter is limited, which directly leads to a very limited range of gravitational force generated by these matter. This makes the galaxy matter present in a fluid state.

3 The range of gravity of the masses inside the MW disc

From the above analysis, it can be seen that in the three-layer structure of the Milky Way, the kernel of the Milky Way and the bulge part of the Milky Way, basically all matter is within the range of gravity generated by the internal mass of these structures. To the outside of the bulge of the Milky Way, the gravity of the kernel and bulge of the Milky Way will not be able to extend out.

Considering that the mass of the Milky Way's disc accounts for about 80% of the total mass of the Milky Way, it can be estimated that the mass of the MW disc is approximately$1.2 \times 10^{12} m_{\odot}$

According to the MW disc, the radius is about 100,000 light-years and the thickness is 2,000 light-years. Excluding the 20,000 light-year dense substances in the bulge part, the volume of the disc can be calculated to be approximately

$$V = 3.14 \times 100^2 \times 2 \times 10^9 = 6.28 \times 10^{13} ly^3$$

So the mass density of the disc is

$$\rho = 1.9 \times 10^{-2} m_\odot ly^{-3}$$

Therefore, in order to achieve the corresponding mass-generated space-time structure range just in line with the mass distribution range, it needs to meet (length units are converted to light years)

$$R = \sqrt[3]{\frac{\rho v}{m_\odot}} \times 10^{-2} ly$$

Where *v* is the volume of the space-time structure radius *R* formed by this part of the mass, so

$$v = 3.14 \times 0.2 \times R^2$$

So

$$R^3 = \frac{\rho v}{m_\odot} \times 10^{-6} = 1.9 \times 10^{-2} \times 10^{-6} \times 3.14 \times 0.2 \times R^2$$

Then

$$R = 1.9 \times 10^{-2} \times 10^{-6} \times 3.14 \times 0.2 ly = 1.2 \times 10^{-8} ly = 1.2 \times 10^8 m$$

It can be seen that such a space-time distribution range does not exceed the galaxy masses coverage of the solar system. Therefore, if the galaxies in the Milky Way are scattered in locations where galaxies such as the Solar System are located, the galaxies in the Milky Way basically move independently and freely in the Milky Way, and will not be affected by the gravity of the galactic bulge or surrounding galaxies.

However, since the Milky Way is a spiral galaxy, the mass density of the galaxies in the spiral arms of the spiral will far exceed the mass density of the galaxies at the position of the solar system. In this case, the spiral galaxies with spiral arms will have a limited distance of gravitational interaction, thereby restricting the shape of the spiral arms.

4 summary

It can be seen from the above analysis that the new space-time structure can be used to better explain the distribution of matter in the Milky Way. The matter distribution of the Milky Way mainly consists of three parts, namely the kernel part, the bulge part and the disc part. The radius of the spacetime structure formed by the kernel material can reach 14 light years. Considering that the material in this part of the kernel is very dense, the kernel part should be able to maintain a relatively complete spherical shape.

The bulge in the center of the Milky Way has a spacetime structure distribution radius of 4,700 light years. Therefore, within a radius of 4700 light-years, galaxies should be able to feel the gravitational force generated by all the masses within this radius, and the matter or galaxies in this part should be able to maintain a spherical shape. The height of the bulge of the Milky Way currently observed is about 10,000 light-years, which is very close to this calculation. On the other hand, there is a radius of 20,000 light-years in the horizontal direction, which means that in the horizontal direction, some matter in the bugle is outside the gravitational range formed by all the matter in the bugle. This may also be the reason why the bulge cannot form a complete spherical shape.

The density of matter in the disc of the Milky Way is relatively small. The calculated average spacetime radius is only 120 million meters according to this density. It can be seen that a large part of the matter in the disc is in a very free state of motion, and there is almost no gravitational interaction with the surrounding galaxies. This is also similar to the space-time structure of our solar system. The solar system appears to be basically unaffected by the gravitational interaction of neighboring galaxies. Otherwise, we should consider the influence of the mass of these neighboring galaxies when calculating the orbital motion of the planets in the solar system.

If the galaxies in the disc are basically in a state of free motion, this can explain why the galaxies on the MW disc have abnormal velocity curves. But here comes a new question, that is, if this is the case, how can the Milky Way and other galaxies maintain their current disc structure? Perhaps it is like a water droplet in a weightless state, relying entirely on the interaction between adjacent molecules to maintain the spherical shape?

Thanks

During my period of thinking about the change of the gravitational constant and the new spacetime model, I had a very useful discussion with Dr. Rupert Sheldrake on the change of the gravitational constant. Under his prompt, I reconsidered other factors that affect the change of the gravitational constant. I also want to thank Lev Verkhovsky from Russia. I discussed with him about the change of the frame of reference and found that some of his ideas are closer to mine.

References

[1] Cheng, Z. The Origin of Spacetime and Its Influence on the Gravitational Constant.

https://vixra.org/abs/2008.0164

[2] Cheng, Z. The Influence of the Correction of the Gravitational Constant on the Precession of Mercury’s Perihelion. https://vixra.org/abs/2008.0171

银河系的时空结构

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***摘要**：本文用新的时空模型来分析银河系的时空分布范围。新的时空模型能够比较好地解释银河系的三层结构。这三层结构分别是银心，隆起和银盘。分析结果表明银心物质的引力能够作用于其中所有的质量。隆起部分物质产生的引力只能够覆盖其中大部分物质，但隆起边缘部分物质无法被覆盖到。银盘上的物质密度很低，这导致银盘中密度比较低的区域星系基本上自由运动。而螺旋臂上的星系之间则会产生较强的引力相互作用。然而新模型要解释在很多星系处于自由运动的情况下，仍然能够维持盘状结构的原因，可能还需要借助暗物质的概念。*

1 导论

对于时空的起源，较少有论文涉及。我这段时间分析了基本粒子携带的静电能，发现该能量在各种标准物理模型中是被忽略的。如果我们将这种静电能看作是和质量性质一样的东西，则可以发现物质的静电能分布范围远超对应的质量分布范围。这么大范围的能量分布的存在，唯一可以对应的物理量就只有时空了。这样，一种全新的时空模型被建立起来了。如果将这种时空结构的新模型应用到星系结构当中，我们就可以发现，星系物质所形成的时空结构是有限的。而有限的时空覆盖范围又可能意味着引力作用范围的有限性。

太阳系的时空结构基本上能够覆盖整个太阳系，因此可以借助牛顿力学或广义相对论进行分析，太阳系能够形成行星围绕太阳运转的固定轨道。

从文献[1]的分析结果来看，太阳系的时空结构半径大约为 10^{14}m。这个时空覆盖范围也可以从水星近日点进动的数据分析获得证实[2]。

然而将这个模型应用到银河系的范围之中就可以发现银河系所有物质形成的时空结构分布远小于银河系的半径。这就是说银河系的物质所形成的时空结构无法覆盖整个银河系。那么是什么原因维持银河系的结构的，这是值得深入探讨的问题，或许确实需要暗物质来进行约束。由于引力作用范围的有限性，意味着银河系中的物质结构更类似于流体。当然时空分布范围并不意味着引力的作用范围一定会受到这个时空范围的限制。如果有暗物质的存在，或许暗物质也可以成为引力传递的介质。

2 银河系各部分物质所形成的时空结构范围的估算

对于银河系最核心的物质，其质量目前的估算大约为 200 万个太阳的质量。因此以太阳系的

时空结构半径大约为 10^{14}m 作为标准，然后由文献[1]的公式进行估算可以得到

$$R_{MWK} = \sqrt[3]{kM_{MWK}}r_c = \sqrt[3]{\frac{M_{MWK}}{M_{sun}}}\sqrt[3]{kM_{sun}}r_c \approx \sqrt[3]{2\times 10^6}\times 10^{14}m \approx 1.4\times 10^{17}m$$

即覆盖了大约 14 光年。这部分的物质应该能够保持一个完整的球形的形状。

如果按照银河系中心的隆起部分来进行估算，该部分拥有大约 15%的银河系质量，如果考虑到银河系的总质量大约为$1.5\times 10^{12}m_{\odot}$
可以估算出该部分产生的时空覆盖范围大约为

$$R_{MWC} \approx \sqrt[3]{0.15\times 1.5\times 10^{12}}\times 10^{14}m \approx 4.7\times 10^{19}m$$

时空覆盖范围大约为 4700 光年。目前观察到的该部分的横向直径大约为 2 万光年，隆起高度大约为 1 万光年。可以看出这个计算数值跟银河系中心的隆起高度基本一致。
而对于整个银河系，可以计算出银河系总质量能够形成的时空结构分布范围：

$$R_{MW} \approx \sqrt[3]{1.5\times 10^{12}}\times 10^{14}m \approx 1.2\times 10^{20}m$$

可以看出如果银河系的所有物质集中在一起，所形成的时空结构半径也只有一万二千光年。

而我们现在已知的整个银河系半径达到 10 万光年以上。因此银河系中的物质分布已经远超银河系质量本身所能够形成的时空结构范围。这也意味着这些物质已经不能够像在太阳系这样的星系中那样按照牛顿定律或者广义相对论的原理做封闭的椭圆轨道运动。

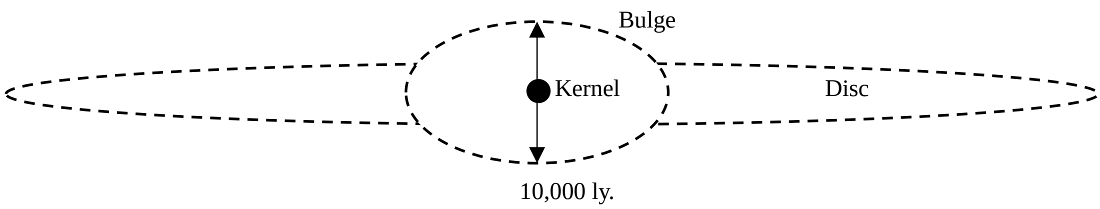

Figure 1. The spacetime structure of Milky Way

图 1 显示了银河系的三个比较典型的时空结构。分别是最里层的银河系核心，该核心部分质量大约 200 万个太阳质量，半径大约为 1 光年。银河系核心部分为完整的球形结构。而离开核心之后，物质开始出现离散的分布。物质分布范围已经超过了这些物质所形成的时空结构范围。该部分质量大约为 1.5 trillian 个太阳质量，半径大约为 1 万光年，隆起高度大约为 1 万光年。而到了银河系的外围，由于物质分布范围远超这些物质所形成的的时空结构范围，因此这些物质按照初始被抛射出银河系中心的方向，形成一个扁平的物质分布。而由于物质

分布很离散，局部的物质所形成的时空结构范围有限，这也直接导致了这些物质所产生的引力作用范围非常有限。从而使得星系物质呈现流体状态。

3 银盘内部物质引力作用范围

从上面的分析可以看出在银河系的三层结构之中，银河系的核心和银河系的隆起部分，基本上所有物质都处于这些结构内部质量所产生的引力作用范围之内。而到了银河系隆起的外部，则银河系核心和隆起部分的引力将无法延伸出去。

考虑银河系银盘的质量大约占据了银河系总质量的 80%，因此可以估算银盘质量大约为 $1.2 \times 10^{12} m_{\odot}$

而按照银盘的半径大约为 10 万光年, 厚度为 2 千光年。除去隆起部分 2 万光年的致密物质，则可以计算出银盘的体积大约为:

$$V = 3.14 \times 100^2 \times 2 \times 10^9 = 6.28 \times 10^{13} ly^3$$

这样银盘的物质密度为

$$\rho = 1.9 \times 10^{-2} m_{\odot} ly^{-3}$$

因此要达到相应的质量产生的时空结构范围刚好与质量分布的范围一致，需要满足（长度单位都换算成光年）

$$R = \sqrt[3]{\frac{\rho v}{m_{\odot}}} \times 10^{-2} ly$$

其中 v 为该部分质量所形成的时空结构半径 R 的体积，因此

$$v = 3.14 \times 0.2 \times R^2$$

因此

$$R^3 = \frac{\rho v}{m_{\odot}} \times 10^{-6} = 1.9 \times 10^{-2} \times 10^{-6} \times 3.14 \times 0.2 \times R^2$$

可以计算出

$$R = 1.9 \times 10^{-2} \times 10^{-6} \times 3.14 \times 0.2 ly = 1.2 \times 10^{-8} ly = 1.2 \times 10^{8} m$$

可以看出这样的一个时空分布范围都没有超出太阳系的星系质量覆盖范围。因此如果银河系中，在太阳系这样的星系所处的位置，星系分布比较分散，则其中的星系基本上在银河系中是独立自由运行的，并不会受到银心或者是周围星系的引力影响。

但是由于银河系属于螺旋星系，因此在其螺旋的旋臂上面，星系的质量密度会远超太阳系位置的星系质量密度。在这种情况下，螺旋的旋臂星系之间将产生有限距离的引力相互作用，从而制约旋臂的形状。

4 总结

从上述分析可以看出，利用新的时空结构，可以比较好地解释银河系的物质分布情况。银河系的物质分布主要包含了三个部分，分别是核心部分、隆起部分和银盘部分。其中核心部分的物质所形成的时空结构半径可以达到 14 光年。考虑到这部分核心的物质非常致密，因此该核心部分应该能够保持一个比较完整的球形的形状。

而银河系中心的隆起部分, 其中包含的物质所形成的时空结构分布半径可以达到 4700 光年。因此在半径为 4700 光年的范围之内，星系都应该能够感受到该半径范围之内的所有质量所产生的引力，这部分的物质或星系应该能够保持球形的形状。目前观察到的银河系隆起部分高度大约一万光年，跟这个计算结果非常接近。而横向则有 2 万光年的半径，说明在横向，隆起部分已经有部分物质位于隆起部分中的所有物质所形成的引力范围之外。这也可能是隆起部分无法形成完整球形形状的原因。

而银河系银盘部分的物质密度比较小。所计算出来的平均时空半径只有 1.2 亿米，可以看出银盘中很大一部分物质是处于非常自由的运动状态之中, 跟周围的星系几乎没有引力相互作用。这也跟我们现在的太阳系所处的时空结构差不多。目前太阳系看起来基本上没有受到相邻星系的引力相互作用影响。否则我们在计算太阳系行星轨道运动的时候就应该考虑这些邻近星系的质量的影响。

如果银盘中的星系基本上处于自由运动的状态, 这倒是可以解释为何银盘上的星系速度曲线异常的问题。但是这里又带来了新的问题，就是如果真的是这样状况，那银河系以及其他的星系又如何保持现在这样的盘状结构？或许就如同失重状态下的水滴一样, 完全是依靠相邻分子间的相互作用力来保持球形的形状？

感谢：在我这段时间对引力常数的变化和新的时空模型的思考过程中，我跟 Dr. Rupert Sheldrake 就引力常数变化问题进行了非常有益的讨论。在他的提示下，我重新思考了影响引力常数变化的其他因素。另外也要感谢来自俄罗斯的 Lev Verkhovsky, 我跟他探讨了有关参照系尺度的变化问题，发现他的一些想法跟我的想法比较接近。

参考文献

[1] Cheng, Z. The Origin of Spacetime and Its Influence on the Gravitational Constant. https://vixra.org/abs/2008.0164

[2] Cheng, Z. The Influence of the Correction of the Gravitational Constant on the Precession of Mercury’s Perihelion. https://vixra.org/abs/2008.0171