Spiral Arms Around a Star: Geometric Explanation

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Formulation of the problem. Spiral arms are typical in galaxies: this is what our own Galaxy consists of. There are many physical theories that explain the appearance of logarithmic spiral arms in galaxies.

Recently, very similar spiral arms were discovered around a star [3]. The geometric shape is similar, but, because of the different scale, galaxy-related explanations cannot be directly applied. So, a natural question is: how to explain the appearance of spiral arms around a star?

Our explanation. For galaxies, several dozen different physical theories have been proposed, all of which explain the same spiral shape. The very fact that all these theories, based on completely different physics, successfully explain the same shape led researchers to conclude that this shape must have a simple geometric explanation, and such an explanation has indeed been proposed [1, 2]. Namely, the distribution of matter close to the Big Bang was practically uniform and homogeneous, i.e., invariant with respect to shifts, rotations, and scalings. However, such a distribution is unstable: if at some point, density increases, matter will be attracted to this point, and the disturbance will increase.

According to statistical physics, it is more probable to go from a symmetric state to a state where some symmetries are preserved – and the more symmetries are preserved, the more probable the transition. From this viewpoint, the most symmetries are preserved if matter forms a planar disk – which explains the flat appearance of most galaxies, and after that – when it forms a logarithmic spiral, which explains the ubiquity of spiral galaxies.

Our idea is that the exact same geometric explanation can also explain the spiral arms around a star.

References

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