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P3_3 Dirty Deeds Done Dirt Fast - The Feasibility of Tusk's Infinite Spin

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Abstract

In *JoJo's Bizarre Adventure*, Tusk: Act IV is able to trap people by using the power of 'Infinite Spin.' Assuming this imprisonment is caused by a Kerr black hole, it was found that the speed at which a fingernail would need to spin to create such a body is in the order of 10^{14} rad/s. However, even the smallest real event horizon would be hundreds of metres across, and the slightest change in nail shape or rate of spin could cause the black hole to massively change in size.

Introduction

In *'Steel Ball Run'* - the 7th part of the popular manga series *'JoJo's Bizarre Adventure'* - several characters develop supernatural powers, known as 'Stands' [1].

Johnny Joestar, the protagonist, develops a Stand known as 'Tusk', giving him the ability to spin his fingernails, and fire these spinning nails as bullets. Tusk grows in power through the story, eventually becoming able to create an effect referred to in-universe as 'Infinite Spin.'

When Infinite Spin occurs, anyone struck by Johnny's nails becomes trapped in a region where nothing can escape. This region even persists between different universes within the story of Steel Ball Run, and according to Johnny, does so by harnessing the power of gravity.

A Kerr Black Hole

The Kerr solution for the Einstein Field Equations describes a spinning black hole [2]. Such a body would prevent anything which crosses its event horizon from leaving, and under specific conditions may also connect different regions of Space-Time together, such as different universes. A Kerr black hole could then explain both of the main effects of Infinite Spin and in a manner which arises as a result of gravity.

The radius, r, of the event horizon for a Kerr black hole is given by,

$$r = M_k \pm \sqrt{M_k^2 - \frac{J}{M_k}^2}, \quad (1)$$

where M_k is the mass of the black hole, and J, the angular momentum of the black hole [3][4]. While the Kerr black hole has two event horizons, only the larger of the two needs to be considered. As Tusk makes Johnny's nails spin, their energy should increase, and thus their effective mass.

A rotating flat body has angular momentum, J given by,

$$J = I\omega = \frac{\omega r_1 r_2 (r_1^2 + r_2^2)}{12}, \quad (2)$$

and an angular energy given by,

$$E = \frac{I\omega^2}{2} = \frac{\omega^2 r_1 r_2 (r_1^2 + r_2^2)}{24}, \qquad (3)$$

with I being the angular inertia, and ω being the angular velocity of the spinning body. r_1 and r_2 are the width and height, respectively, which for fingernails are 0.3 cm wide and 0.9 cm long [5][6].

By using the energy-mass relationship, $E = M_0 c^2$ (c being the speed of light, and M_0 the rest mass of a body) it is possible to find how the effective mass of a body changes due to increasing angular energy. Assuming that adding M_0 for a single finger nail would be negligible, the effective mass, M, is given by,

$$M = \frac{\omega^2 r_1 r_2 (r_1^2 + r_2^2)}{24c^2}. \qquad (4)$$

Substituting this into the equation for the Event Horizon of a Kerr Black hole, a relationship between angular velocity and the event horizon's radius is found,

$$r = \frac{\omega^2 r_1 r_2 (r_1^2 + r_2^2)}{24c^2} + \sqrt{\frac{\omega^4 r_1^2 r_2^2 (r_1^2 + r_2^2)^2}{576c^4} - \frac{4c^4}{\omega^2}}. \qquad (5)$$

Equation (5) cannot easily be rearranged for r, so instead a graphical approach was used, employing R. Figure 1 shows a plot of ω against r.

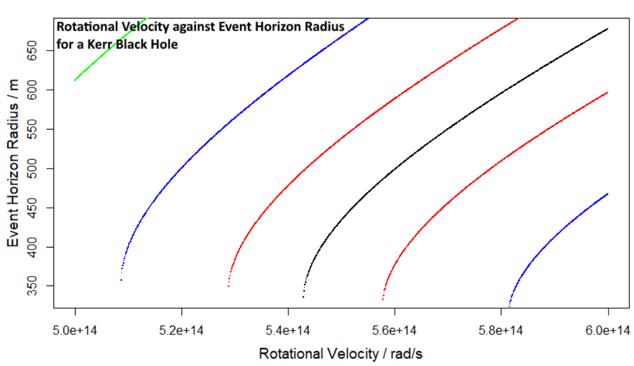

Figure 1: ω against r. The black line gives the relationship for the given values of r_1 and r_2. The red lines are a change in r_1 and r_2 of $\pm 2\%$, the blue $\pm 5\%$ and the green $\pm 10\%$.

Conclusions

While Tusk would have to cause Johnny's nails to spin at speeds upwards of 10^{14} rad/ s, this immense rate of rotation is not even the greatest constraint for creating Infinite Spin.

As Figure 1 shows, the minimum event horizon is hundreds of metres across. Finding the value at which the root in Equation (5) = 0, by equating $M^2 = a^2$ allows a minimum value for ω to be found. With this taken as ω_{min}^2 and the root is set to zero, the minimum non-complex radius of the event horizon can be found,

$$r = M = \frac{\omega_{min}^2 r_1 r_2 (r_1^2 + r_2^2)}{24c^2}. \qquad (6)$$

This gives the minimum event horizon at 332 m. An event horizon this large would easily envelope not only Johnny's target, but Johnny himself. In addition, even a small change in the size of Johnny's nails produces a great difference in the speed at which they must spin. Even if Tusk were to have the precision to control ω to a unreasonably high degree of accuracy, this speed would vary between each of Johnny's fingernails, and would change over time as his nails grew or became damaged.

As such, the use of spinning fingernails to create a Kerr Black Hole is dangerously imprecise, even if one were to somehow create the sufficient speeds required.

References

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