The "vaixell piratta" attraction

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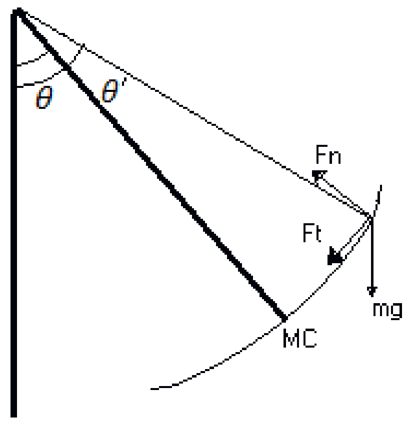
With this experiment we wanted to explain physically why the sensations in the rear part of the "vaixell piratta" attraction were bigger than in middle, and check whether or not we could get to microgravity conditions.

1. Introduction

In this paper we are going to apply the basis of mechanics to explain the behavior of an attraction, using as a model the pendulum. What we are trying to do is check if the acceleration at the rear part of the attraction is bigger than in the middle, and, if possible, find a point where it is 0, which would mean microgravity conditions.

2. Theory



In order to study easily the behavior of the attraction, we are going to suppose that its movement is the same of a pendulum.

We are going to call θ' the angle in which we are situated and θ the angle in which the center of mass is situated.

As seen in the figure, the attraction makes two kind of forces to the person, the normal and the tangential forces, which, by Newton laws, are:

$$F_n = \frac{mv^2}{r} + mg\cos\theta'$$

$$F_t = mg\sin\theta - ma_t = mr(\frac{g}{r}\sin\theta' - \ddot{\theta})$$

But the energy expression and the movement of the pendulum expression are:

$$E = \frac{mv^2}{2} + mgh = mgh_M$$

$$\ddot{\theta} = -\frac{g}{r}\sin\theta$$

Where the subscript M means maximum. So we simplify the expression into angle dependency:

$$F_n = \frac{mv^2}{r} + mg\cos\theta' = mg(2\cos\theta - 2\cos\theta_M + \cos\theta')$$

$$F_t = mg(\sin\theta' - \sin\theta)$$

Some considerations we can make are:

- When $\theta' = \theta$ then $F_t = 0$, so no tangential force is felt in the middle of the boat.
- The term of F_n , $2mg\,(\cos\theta - \cos\theta_M) \geq 0$, gets its minimum at $\theta = \theta_M$, and $mg\cos\theta' \geq mg\cos\theta'_M$, and also gets its minimum at $\theta' = \theta'_M$ (which implies $\theta = \theta_M$). So F_n will get a minimum in its highest part of the movement, when $\theta = \theta_M$, and its value will be $F_{nm} = mg\cos\theta'_M$.
- If we want to reduce F_{nm} to the minimum between all the positions in the attraction, we get that we must find the highest θ'_M, which clearly is gotten by the rear part of the attraction.
- If we look for the maximum of F_n we get that it is gotten at $\theta' = \theta = 0$, and its value is $F_{nM} = mg(3 - 2\cos\theta_M)$.

Taking everything said into account, in the middle of the attraction we get no tangential experience and the maximum of normal force when the attraction is in its lowest point. On the other hand, in the rear part of the attraction we get some tangential force, and the minimum of normal force, meaning that if we can make it to the microgravity conditions, it is where we must look for them.

3. Description of the experiment

To do the experiment we used a handmade accelerometer, which would consist of a mass in a tube held by an elastic rubber.

As for two different states with the same acceleration the accelerometer should answer identically, to create the scale we put the tube totally vertical, and then marked the 1g point, and then put it upside down and marked -1g. This, by Hooke laws, would give us the 0g point in a way where the friction had been almost totally removed.

Then the experiment would consist basically on seeing the performance of the accelerometer put vertically and horizontally in the middle and in the rear part of the attraction. As can be deduced from the formulas, the tangential force in the middle should be so weak that the friction should prevent the movement of the mass, and we should get a minimum of normal force in the rear part when it is in its higher part of the movement and a maximum of normal force in the lowest part of the movement.

4. Results

What we obtained was that, as predicted from the expressions, the tangential acceleration was not significant in the middle, the normal force got a minimum in the rear part during the highest part of its movement, and a maximum during the lowest part. What we didn’t expect to happen was that the friction wouldn’t let us have any result for the tangential force in the rear part.

Finally, we saw that in the rear part the normal force got one time 0g, and, as said the tangential force was not significant. This means that the attraction got microgravity conditions.

5. Conclusions

In this experiment we wanted to study the behavior of the “vaixell piratta” attraction by studying the accelerations that one suffers in it, proved our objectives theoretically, and checked them checked the results by using and accelerometer. The only problem we got was the excess of friction when putting the accelerometer horizontally, but it could be solved by showing that the tangential force was too weak.

Bibliography

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