Einstein’s general relativity theory predicts the fact that given enough mass, a star would collapse into a black hole. In the middle of the black hole it is said to be a gravitational singularity. Einstein’s equations predict that in such a point the mass of the object becomes infinite. Mathematically speaking, this can be interpreted by calculating a limit of a fraction, where the denominator is 0 and the numerator is a constant.

Let’s assume that the density of the object becomes infinite. That would mean that:

, where V is the volume of the object and m is the mass.

Such and equation would basically predict that the entire mass of the star is concentrated in a single point, which would be the equivalent of a black hole.

In nature, no actually singularities have ever been found, even though they have been mathematically predicted. The presence of a singularity generally indicates that the model is incomplete.

This paper will try to tackle this incompleteness.

Let us assume a Cartesian grid, where we define the point p of coordinates A and b.

|  |
| --- |
|  |
| Fig. 1. The point p of coordinates A and B |

If we define the coordinates A and B to be of a specific value, then we can be sure about the fact that the point p is indeed in the location (A,B).

Let’s now assume the case that we do not define the coordinates A and B, but instead we try to determine these coordinates by a process of measurement.

In order to do this, we would most likely use some sort of a ruler. A good ruler would give us fairly accurate results, a bad ruler might give us poor result. Either way, the results will never be 100% accurate, meaning that, no matter what process of measurement we apply, there will always be errors.

As it is known, all errors can be described by the Gaussian distribution, or the bell curve.

|  |
| --- |
| Normal distribution - Analytica Wiki |
| Fig. 2. The Gaussian distribution |

What does this tell us about the position of the point P?

Given that in order to determine the position of the point P we have to apply some measurements, we can only determine it’s position with a certain degree of accuracy, described by the bell curve.

Let us now assume that instead of making one or two measurements, we make an infinite amount of measurements.

What can this tell us about the position of the point?

Because the Gaussian distribution never actually reaches the value of 0 but instead tends to be asymptotically going to 0, for any given combination of points (A,B) resulted after the process of measurements, the probability of obtaining that particular combination of values at least once is equal to 1. Meaning to say, if we measure an infinite of times, we can be sure that a finite combination of (A,B) will be achieved.

Let us now revert to the case of gravitational singularity.

We assumed that the density would become infinite, because the space in which matter would be concentrated would become equal to zero. The first observation we must make consists in the fact that it would not be actual zero, but a point which is considered equal to zero from a mathematical perspective.

The question now becomes: what type of point are we discussing?

If we are in the first case, where we assume that the position of the point is exactly defined as P(A,B), then indeed the density would become infinite, because that point is defined as 0. But what about the second case, where we don’t actually know a priori the position of the point P, but instead we try to determine it by a process of measurements?

In the second case, we would have to consider the following aspects:

Every star is comprised of a very large number of atoms. All these atoms overlap each other in a single point. But because we are trying to determine the position of that point, that “entity” we define as a point will no longer be of size 0. That “entity” that we call point, will in fact be a mathematical construct who’s position can only be approximated by a Gaussian curve; meaning to say, that that point will no longer have a certain given position, but rather a distribution of position probability. Furthermore, this implies that no matter what our measures devices tell us, the point can be anywhere, with a certain probability. For common day’s events, this observation might be irrelevant. But In the case of a star, we are talking about a very large number of atoms, every single one of those atoms having a probability of position.

Let us now consider a black hole. It has been theorized that the black hole has a radius, given by the Schwarzschild solution to Einstein’s field equation.

Given that it has been theorized that black holes actually have a radius, and are not just points of 0 sizes in space can we calculate that radius based on the number of atoms comprised in a black and their distribution of position?

Let us consider a black hole which mass is 2 times the mass of the Sun. Such a black whole would have a radius of 5908 km.

Let’s assume now the radius of an atom. The radius of an atom is about 10e-10/2 meters.

Following the probability distribution of the Gaussian curve, we will make the assumption that the radius of an atom represents 1 standard deviations. The meaning of the previous statement might be hard to understand. In order to better understand it, let us consider the following idea:

What we have defined as a point of given coordinates (A,B) is in fact the part of the Gaussian curve that accounts for 95.4 of the total probability distribution. Meaning to say, that the probability of an atom to find itself in the center of a black hole, in a space no large than its own radius is 96.4%%. But what about the rest of 3.6%?

In order to answer this question, we must start from the following question: what is the probability that at least one atom from all the atoms forming the black whole will find itself at a distance d = 5.908km from the center of the black hole?

First we have to calculate the probability of one atom find itself at a distance of 5908m from the center of the distribution, given that one standard deviation has the value of 10e-10/2 m.

After a simple division, we find that the probability of one atom to be so far away would have to be 1.1816e+13 standard deviations

The probability of one atom being at 1.1816e+13 standard deviations away is roughly equal to 5e-10.

If we consider a black hole which is twice the mass of the Sun, the approximate number of atoms forming this black hole would be 2\*1.1883315 × 10^57 atoms.

The probability is called a conditional probability can be computed with the following formula:

The formula for the calculation is

In our case we can apply the formula:

//// Lets assume now that the mass of an atom is 1.9926E-26 kg (one fifth of the carbon 12 atom). De dezvoltat cu alta ocazie

Now let’s ask a different question: how many atoms with a probability of 50% would we be likely to find at the distance d = 5908 m from the center of the black hole?

We will use the compound probability

0.5 = , where x is the number of atoms

The solution is:

|  |
| --- |
|  |
|  |