Einstein's Field Equation

$$T = \frac{c^4}{8\pi G} G$$

The famous Einstein's Field Equation, above, is really 16 quite complicated equations expressed in a concise way. The '***T***' and the large '***G***' are called "tensors" and each is a 4 x 4 matrix of formulas. The stress energy tensor '***T***' describes the distribution of mass, momentum and energy, while the Einstein curvature tensor '***G***' represents the curvature of space and time.

The constant $\frac{c^4}{8\pi G}$ is a measure of the stiffness of space and time. It is an enormous number made up from the speed of light (300,000,000 metres per second) multiplied by itself 4 times and divided by the universal constant of gravitation 'G' which is equal to 6.67×10^{-11} $m^3\ kg^{-1}\ s^{-2}$.

Because 'G' is such a small number, gravity is the weakest of all known forces. However the fourth power of the speed of light is an extraordinarily large number, and divided by 'G' it becomes one of the largest numbers used in any field of science: 4.8×10^{42}…that's 42 zeros:

4,800,000,000,000,000,000,000,000,000,000,000,000,000,000,000

Newton assumed that matter and energy would have no effect on space or time. Einstein's theory shows that, while Newton's theory is not correct, it is a good approximation for "human-sized" amounts of matter and energy. However, "astronomically" large amounts of matter have easily measurable effects. The massive Sun warps space distorting the positions of stars and changes the orbits of planets.

Near black holes' space is extremely distorted as illustrated in many of our exhibits.

Einstein's Field Equation tells us that space is elastic and because it is elastic, it can sustain waves. The vast warping of space when black holes form or collide cause enormous ripples in space which travel out at the speed of light. These are the *gravitational waves* being sought by thousands of physicists all around the world, including those working at the research centre next door.

Those 42 zeros in the Field Equation's mean that gravity waves are the tiniest and most difficult thing anyone has ever attempted to observe, and yet the equations also tell us that those waves carry unimaginably large amounts of energy as they sweep across the Earth.