5.2

Soliton

Have you heard of this exotic wave: a solitary wave or soliton? This exhibit gives a visual representation of what a soliton wave may look like (even though it is not exactly a soliton wave itself).

These soliton waves (i) maintain their shape as they move, and (ii) can emerge unscathed after a collision with another soliton. They are also special, because the "louder" they are, the faster they move.

Contrast this with the "usual" waves such as the sound or the light – their speed does not depend on their loudness.

Where do solitons occur? Solitons were first observed on surface of water, but they also occur in optical fibres used to form the network that carries internet data, in some DNA and other biopolymers.

5.2

What is the mathematics? Soliton solution were discovered in very special types of equations which have a property that, even though they are nonlinear equations, they can be solved exactly, in contrast to the chaotic pendulum or the long oscillating spring. One of the examples of equations which has solutions that are solitons is known after two mathematicians, the Korteweg-de Vries equation (KdV equation for short):

(5) $$\frac{\partial W}{\partial t}+\frac{\partial^3 W}{\partial x^3}+6W\frac{\partial W}{\partial x}=0.$$

There is a lot of beautiful mathematical ideas related to such waves and many of them are still being explored by mathematicians and physicists.