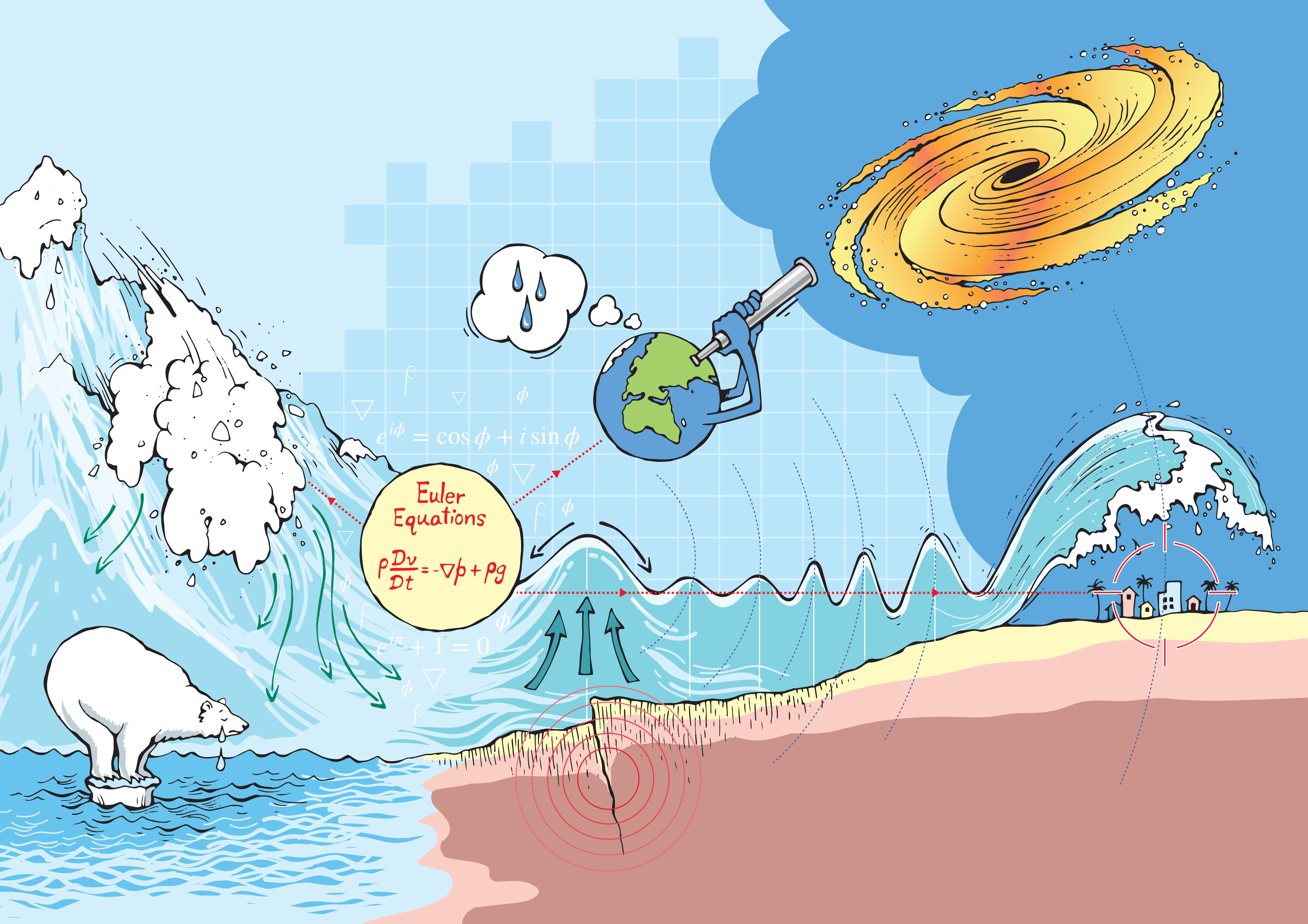
MATHEMATICAL SCIENCES



MAKING SENSE OF NATURE WITH MATHEMATICS

Imagine being able to predict when and where a tsunami wave will hit. Or being able to predict the path of an avalanche. Think of how much destruction could be prevented by predicting these natural phenomena accurately. What if mathematics provided a way of understanding them? What if mathematics and all the computing power available to us could tell us if there are planets in galaxies far away that could support human life?

In the 18th century the Swiss mathematician Leonhard Euler developed an equation to describe the properties of liquids and gases which have no viscosity.

The Euler equations are applied widely in natural and engineering sciences to understand phenomenon that involve fluid flows. Natural phenomena from avalanches to tsunamis to collapsing supernovas and solar waves can be studied using these equations. How is this even possible? As with any problem, breaking them down into solvable smaller questions helps. In the case of these natural phenomena, we know that they are essentially constituted of movement of fluids—snow, water or gases. This is where the Euler equations come into play.

Prof. Siddhartha Mishra uses a combination of equations and algorithms to better understand the movement of avalanches.

This mathematical modeling step involves Mishra and his collaborators using partial differential equations to describe the movement of the powdery snow in avalanches and then designing algorithms which would allow for near exact simulations of these avalanches on computers. The complexity of these mathematical models means that the simulations might have to be performed on supercomputers.

These methods are used to calculate the impact of a tsunami wave triggered by an earthquake. The real-world importance of Mishra's work includes being able to predict a tsunami triggered by an earthquake, which would be enormously useful for engineers and for designing accurate risk maps.

The scope of Prof. Mishra's work is enormous. These simulations can be used in a wide range of scenarios that involve urgent problems such as climate change. Mishra's work could potentially also be used to simulate the climate on newly discovered exoplanets. This could then help scientists to know which planets are habitable.