

## HIERARCHY OF SCIENCES

## How hard is physics?

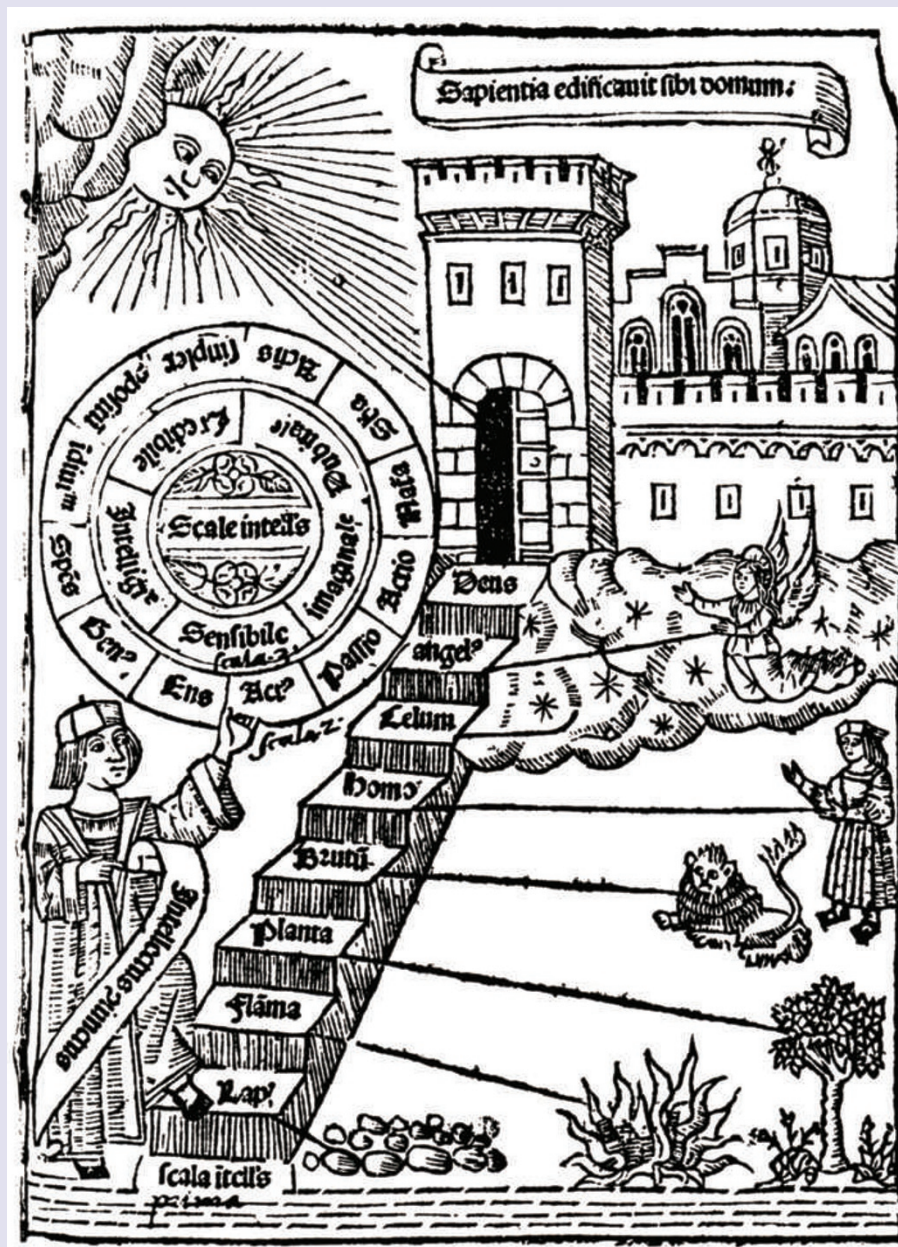
Knowledge has often been arranged in some form of hierarchical structure; the path to absolute knowledge — or to the divine — figured to proceed through several circles or discrete steps of enlightenment. The concept is captured in the 'Lullian staircase': in his 1303 book *De Nova Logica*, the Majorcan theologian and philosopher Ramon Llull describes such divine order, reaching from rocks to flames, to plants, animals, humans, the sky, angels and, ultimately, God (the illustration is from the edition of 1512).

Similar ideas were later put forward by philosophers of science, who tried to arrange hierarchically the different disciplines of scientific enquiry. In particular, nineteenth-century philosopher Auguste Comte came up with a systematic classification of all sciences. For him, sociology ranked highest, as the most complex but least developed discipline, making it the queen of all sciences.

You may disagree. And not surprisingly, the question of how a hierarchy of sciences should be defined — let alone quantified — has always been controversial. Now, Daniele Fanelli proposes a measure for the 'hardness' of the research done in a scientific discipline, in the sense of "the extent to which research questions and results are determined by data and theories as opposed to non-cognitive factors" (*PLoS ONE* 5, e10068; 2010).

Fanelli's approach is to analyse papers that declare to have tested a hypothesis. He sampled 2,434 such papers at random from 10,837 journals across all disciplines — the physical, biological and social sciences. His hypothesis was that in the 'harder' sciences, experimental results are more readily accepted at face value, leading to more reports of negative results than in the 'softer' sciences, where there are more degrees of freedom to analyse and interpret results.

Indeed, Fanelli does find such trends in his analysis. For example, in the domain of social sciences, the odds of reporting a positive result are 2.3 times higher than in the physical sciences: the lowest percentage of positive results, 70.2%, he found in space science, and the highest,



91.5%, in psychology and psychiatry; physics came in at 84.5%. These findings do support the existence of a hierarchy of the sciences, where scientific rigour and objectivity are (roughly) inversely proportional to the complexity of the subject studied.

It is in the nature of the question posed, however, that there are many and various factors that come into play,

from cultural differences between the 'academic tribes' (such as the extent to which negative results are published) to details of the method by which these data were obtained. In fact, Fanelli discusses a whole series of these factors conscientiously — making this a read all the more worthwhile.

ANDREAS TRABESINGER