Lisa's laws

Leonardo da Vinci is almost as well remembered for his scientific investigations as for his paintings and sculpture. His work as an artist was informed by his insight into science, as his system of 'natural laws' demonstrates.

Martin Kemp

To begin a series on art and science* with Leonardo da Vinci's *Mona Lisa* may seem obvious and even banal. But even such a familiar work can be scrutinised through fresh eyes if we set aside our stock categories of art and science. For Leonardo, the invention of a compelling image was not based on literal imitation of nature or unlicensed imagination but on the remaking of natural effects through the understanding of natural laws derived from 'experience'. The inventor's imaginative faculty or *fantasia* worked in concert with the intellect to recreate an infinity of plausible images.

Every painted effect was, in theory, based on a natural law. I will highlight just three of those laws that are inherent in the *Mona Lisa*. These restate in more compact form what Leonardo wrote about the phenomena of light on surfaces, the formation of spiral configurations, and the huge changes in the bones, flesh and blood in the "body of the Earth".

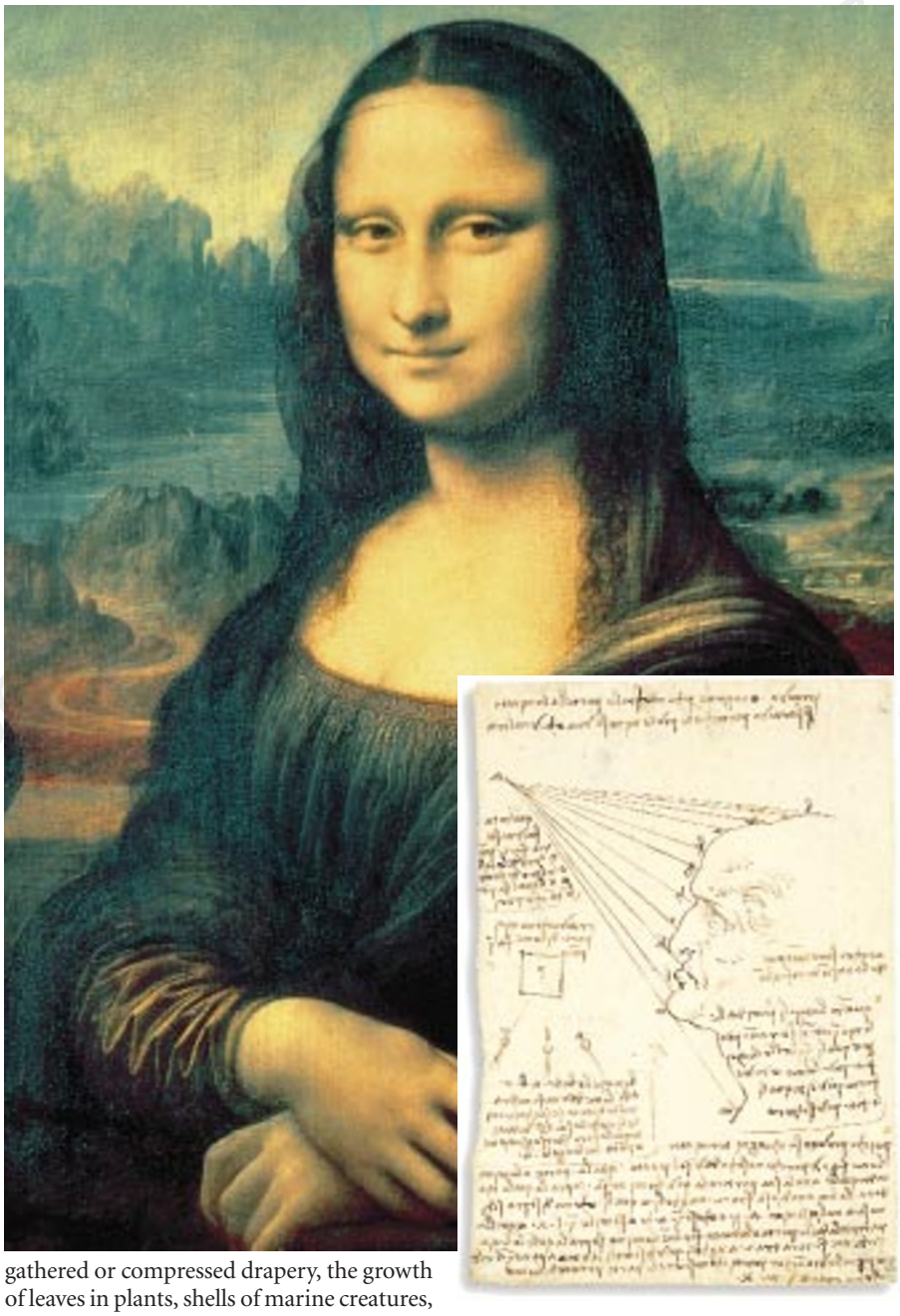
Law 1 "The intensity of light on a plane is proportional to the angle of impact of the light on that plane."

So, on a human head, light from a point source will make its strongest impact when it strikes a surface perpendicularly. When it strikes a glancing blow, the intensity of light at that point will be proportionately weaker. The relative intensities of light on any solid body must be characterized according to this rule.

In the eighteenth century Johann Heinrich Lambert established that the brightness was proportional to the cosine of the angle between the line of sight and that normal to the plane — the law now observed in computer rendering.

Law 2 "A helix arises from the combination of two components: a straight axis corresponding to a linear motion or a weight acting in a vertical direction; and a circular motion or shaping force in a plane perpendicular to that axis."

A current of air or water will exhibit a desire to move forward, just as a weight desires to fall, but will be deflected by successive impacts to induce a revolving impetus, just as a substance that has an inherent desire to curl, such as hair, will be disposed to turn around the axis of its weight. Phenomena that involve direct and revolving impulses include vortices in water currents, ringlets of hair, gathered or compressed drapery, the growth of leaves in plants, shells of marine creatures, spiral staircases and conical gears for clocks.



BRIDGEMAN ART GALLERY

THE ROYAL COLLECTION: HER MAJESTY QUEEN ELIZABETH II

Shedding light on *Mona Lisa*: Leonardo da Vinci's *Demonstration of the Intensities of Light on a Human Face According to Angles of Impact* (inset).

Law 3 "The relative positions of the sphere of water and the 'body of the Earth' are constantly in flux, such that different zones of solid earth are extruded from the sphere of water and become subject to erosion, while the inner caverns of the Earth are also subject to periodic collapse."

So mountains are eroded at their bases, eventually collapsing and damming rivers to form lakes at different levels, the higher of which will in time burst forth, leaving stranded water creatures — as is witnessed by the deposits of ancient shells in high places. □

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*See the explanatory leading article in *Nature* **389,** 213; 1997.