

This too came to rely on the polarimeter as a navigational device in colour space.

The world of post-revolutionary France that Levitt depicts is very much a blend of new and old. This was a society that still retained the medieval notions that comets influence human affairs and that paranormal phenomena could be caused by evil demons. The common view that science gradually eroded these 'superstitions' is belied here. Then, as now, such beliefs are not derailed by science, but mould themselves to fit the science of the times. Just as there is an unbroken train of thought from alchemical transmutation to stellar nucleosynthesis, so the old view of 'occult' forces of nature mutated into Mesmer's animal magnetism (it had already supplied Newtonian gravity), which Arago was surprisingly unwilling to dismiss out of hand. Faraday's demonstration of the magnetic rotation of polarized light only served to strengthen such suspicions.

Meanwhile, vitalism, far from being discredited by Pasteur's attack on spontaneous generation, was given a boost when he followed Biot in proclaiming optical activity a fundamental distinction

between living and non-living matter. That very term, coined by Biot himself, invoked an 'active', life-like agency. The 1852 book by chemist Karl von Reichenbach shows in its very title — *Researches on Magnetism, Electricity, Heat, Light, Crystallization and Chemical Attraction in Their Relations to the Vital Force* — how all these things were considered related. And if it sounds cranky, it was no more so than the kinds of experiment Pasteur conducted in the 1850s, crystallizing organic substances in magnetic fields. Reichenbach's suspicion that crystallization was somehow the link between dead and living matter, and that polarized light distinguished one from the other, finds echoes in the conviction of Ernst Haeckel that birefringent liquid crystals, discovered in 1888, provided evidence of simple matter exhibiting nature's vital organizing principle, leading him in his last book, *Crystal Souls: Studies on Inorganic Life* (1917), to propose that liquid crystals are a genuine kind of life.

And then there is the pervasive presence in late-nineteenth-century science of 'rays'. The tomfoolery of René Blondot's N-rays is now notorious, but what about Reichenbach's Od-rays, allegedly "a cosmic

force that radiates from star to star"? Yet this idea was dressed up in the new optical terminology: Od-rays, visible to only a third of humanity, were polarized. Arago himself entertained a belief in other 'rays' popular in the 1830s, such as an invisible form of 'chemical radiation' and the obscure 'photogenic rays' that Daguerre apparently used to make photographic images. It is easy to see how X-rays and radioactivity fit squarely into this tradition (Biot worked with Antoine and Edmond Becquerel, Henri's grandfather and father, on phosphorescence). But it is equally easy to see how it connects to Renaissance Neoplatonism.

There's much more to this subject than Levitt could attempt to cover in a relatively slim volume, packed though it is with suggestive information. It is no introduction to the subject, but manages, with clarity and energy, to sketch the outline of a much grander story waiting to be told. □

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Stars of the show

FILM

Mention Hawaii and most people think of beaches and palm trees. I think of Mars. During my sole visit to Hawaii as a trainee astrophysicist, I stayed on Mauna Kea, a dormant volcano with barren cinder cones of reddish hue. Dry, cool, oxygen-poor — it was the most extreme

environment I'd ever experienced and I think of it often. With the movie *Hawaiian Starlight* by Jean-Charles Cuillandre, I was transported back to the stark beauty of the summit.

Seven years in the making, the film uses time-lapse photography to showcase the telescopes, the mountain, the sky and the cosmos. All the true-colour images were taken by the Canada-France-Hawaii Telescope (CFHT). Some of the colours of the nebulae and galaxies are so vivid that it's hard to believe that they haven't been digitally enhanced. The accompanying music by Martin O'Donnell and Michael Salvatori heightens this sensory feast.

Despite being thirty years old this year, the 3.6 metre optical/infrared CFHT can still



CANADA-FRANCE-HAWAII TELESCOPE / COELUM

hold its own among the newer telescopes. One of its main advantages is the site. Mauna Kea is nearly ideal for ground-based astronomy. At 4,200 metres, the summit experiences on average 300 clear nights per year. An inversion cloud layer below the summit blocks moisture and light pollution from below, which is critical for submillimetre and optical telescopes alike.

In the film, the different cloud patterns — and their effect on the sunsets — have a significant role. But the real stars are the stars themselves. We're shown where stars are born, where they pass through different stages of evolution and where they die, often dramatically as supernovae. All of this without any narration. For those not familiar with astronomy, the accompanying features include slideshows that explain the physics and astrophysics behind the scenes, among other things.

The experimental format of the film is daring. According to Cuillandre, "the film is first and foremost an invitation to the contemplation of our environment". Without question, he succeeds in wowing the audience. For non-scientists or astronomers, it is perfect. However, for those in between, I can't help thinking that some narration could further enhance the experience. □

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Hawaiian Starlight by Jean-Charles Cuillandre
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