

**Einstein and Spinoza**, short essay for Princeton '55, 50<sup>th</sup> Reunion, May, 2005.

I often recall my professors at Princeton whose wonderful minds stretched my own: Lang, Artin, Feller and Steenrod in mathematics, Alyea and Turkevich in chemistry, Summerfield, Crocco and Hayes in aeronautical engineering, and Shenstone, Bargmann and Wheeler in physics. They were my role models and my reason for continuing as a graduate student at Princeton. Humanity's dignity stems from our ability to think rationally, to understand nature, to love truth, beauty and one another, to be creative and to give back more than we have taken. America is the world's centerpiece for humanity's dignity, and Princeton is at its apex.

We all felt the aura of Einstein during our years at Princeton, and his way of thinking strongly influenced my own. Einstein's famous retort to Niels Bohr, "God does not play dice with the universe", was quoted recently by a wag along with the atheistic interpretation "not because there's no dice; it's because there's no God." Actually Bohr's legendary response was "Einstein, stop telling God what to do." In fact however, Einstein stated many times in his writings and interviews that he was deeply religious in a personal manner and believed in God according to Spinoza's concept. (For a detailed erudite account, see *Einstein and Religion* by Max Jammer.)

In the *Ethics* published posthumously in 1679, Spinoza expressed his conception of God: Every inanimate object in the universe, as well as every living creature and every thought of a human mind, is an expression of the infinite substance, God. This pantheistic view of an all-encompassing God transcends specialized religious creeds and their anthropocentric doctrines, leaving the creation of the universe and its life forms to be understood by developments in science in the future.

Dramatic observational findings in astrophysics since 1998 may indeed have a bearing on Spinoza's conception. The discovery of cosmic speedup, that the universal expansion is accelerating, was first reported in 1998 and is now well corroborated. Cosmic speedup and Einstein's equations for gravity imply the existence of an all-encompassing distribution of Dark Energy (DE) throughout the universe—now known to be the predominant form of all energy, constituting about 73% of the total. Cold Dark Matter (CDM), dominant in the outer halo regions of galaxies, comprises another 23% of the universe's energy. Finally, generalized Visible Matter

(VM) with associated field and  $E = Mc^2$  energies (in protons, neutrons, electrons in atoms and molecules, making stars, planets and visible objects on and around them, like sunshine and life forms) is a mere 4% of the universe's energy.

Although it is only 4% of the total, the understanding of VM has been the much heralded triumph of 20<sup>th</sup> century physics. A precise and elegant theory, the so-called standard model, describes VM in fine detail and is strikingly confirmed by experiments. With regard to CDM and DE, the situation is very different. Known to gravitate in the same way as VM with bodies attracting each other, the more specific nature and properties of CDM are conjectural and still to be determined by continuing astronomical observations. Even more exotic, intriguing and abundant is DE, which gravitates in an *opposite fashion* to both VM and CDM; Dark Energy concentrations repel each other according to Einstein's equations, and it is DE's intrinsic gravitational self-repulsion that is causing the cosmic speedup. (For further details, see *Science*, June 20, 2003.)

All three forms of energy appear to be very thinly dispersed on a cosmic length scale. Vast distances of near-perfect vacuum fill space between galaxies; only in an average sense, on a cosmic scale of hundreds of millions of light years, is DE about 73% of the universe's total energy. On the relatively microscopic scale of terrestrial laboratory experiments and solar system observations, a thinly distributed presence of DE would be masked by the gravitational and other interactions of VM concentrations.

Sixty years ago in *What is Life?*, Erwin Schrödinger concluded that "living matter, while not eluding the laws of physics as established to date, is likely to involve other laws of physics hitherto unknown" to account for its origin. Such laws may take the form of a DE-VM interaction—a precise flow of Dark Energy to Visible Matter under suitable conditions— which served to jump-start the formation and biochemistry of the first living cells on earth, and perhaps then again later to generate the abrupt evolutionary leaps in refinement and greatly increased complexity that occurred as new phyla appeared suddenly, according to the fossil record. (Michelangelo's spark on the ceiling of the Sistine Chapel was perhaps his subconscious awareness of DE being rendered to suitable VM!) Whether a present-day DE-VM interaction contributes small but subtly important energy increments to physical and biological phenomena, such as for example the very small masses of neutrinos and/or the energy transfers between neurons in the prefrontal cortex of a human mind, is an intriguing possibility.

As William James observed in *Pragmatism*: “Truth happens to an idea. It becomes true, is made true by events.” Dark Energy will be elucidated by future investigations, and Einstein and Spinoza’s conception of God, manifest in all matter and mind, may in time be verified in a scientific sense. If so, observational events will have shown Einstein to be right once again.