For example, I wonder whether a particular physical process with which I have much experience qualifies as such a rare gift. The cesium vapor arc, essential for practical thermionic energy conversion, depends crucially on electron trapping in the plasma as the mechanism for space-charge neutralization just as electron trapping was required for space-charge neutralization in the calutron. It also requires the trapping of excitation radiation in the plasma so that the cesium vapor ionizes efficiently, which allows the dense plasma to be maintained with only a 0.5-volt arc potential drop even though the ionization potential of cesium is 3.9 volts.[1] Furthermore, the cesium vapor also adsorbs on the electrodes to increase electron emission 10 000-fold and to give a very low work function that provides more than enough potential difference to maintain the arc.[2]

These multiple and remarkable phenomena combined to give much higher performance than expected for energy conversion, as space-charge neutralization alone gave for the calutron. Does this qualify the cesium vapor arc as a gift of Nature? If not, what specifically does qualify those few physical processes that do?

References

1. N. S. Rasor, *IEEE Trans. Plasma Sci.* **19**, 1191 (1991).
2. N. S. Rasor, C. Warner, *J. Appl. Phys.* **35**, 2589 (1964).

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William Parkins says "the operating company [for the Manhattan Project] was set up as a division of Eastman Kodak called Tennessee Eastman." That statement implies (inadvertently perhaps) that Tennessee Eastman was established as the operating company of the Manhattan Project.

Tennessee Eastman was actually established in 1920 by George Eastman to produce chemicals for Eastman Kodak's film and paper manufacturing operations in Rochester, New York. I suspect that Tennessee Eastman was chosen to be the operating company because it was an established local chemical manufacturing company with the necessary managerial infrastructure in place. A more accurate statement might have been, "The operating company was set up as a division of Tennessee Eastman, a subsidiary of Eastman Kodak."

Albert Einstein to Hedi and Max Born

Translated by Irene Born Newton-John; closing comment by Max Born.[1]

This letter antedates by a year or two the "new" quantum mechanics of Werner Heisenberg, Max Born, Pasqual Jordan, and Erwin Schrödinger. Einstein begins with a response to a letter about Japan by Born's wife, Hedi—a letter that has since been lost. But then, as he would for the next 30 years, Einstein launches into his differences with Max on the interpretation of quantum phenomena. If atomic phenomena are truly random, he grumbles, he'd rather be a croupier.

Berlin, 29 April 1924

Dear Borns,

Your letter, dear Mrs. Born, was really excellent. Indeed, what causes the sense of well-being inspired by Japanese society and art is that the individual is so harmoniously integrated into his wider environment that he derives his experiences not from the self, but mainly from the community. Each of us longed for this when we were young, but we had to resign ourselves to its impossibility. For, of all the communities available to us there is not one I would want to devote myself to, except for the society of the true searchers, which has very few living members at any time.

. . . Bohr's opinion about radiation is of great interest. But I should not want to be forced into abandoning strict causality without defending it more strongly than I have so far. I find the idea quite intolerable that an electron exposed to radiation should choose, of its *own free will*, not only its moment to jump off, but also its direction. In that case, I would rather be a cobbler, or even an employee in a gaming house, than a physicist. Certainly my attempts to give tangible form to the quanta have foundered again and again, but I am far from giving up hope. And even if it never works, there is always that consolation that this lack of success is entirely mine.

. . . With best wishes.

Yours
Einstein

. . . Your pretty remark [Mrs. Born, about subject unknown] makes me want to stroke your head, if that is at all permissible in the case of a married lady.

Max Born's 1969 comments:[1] The letter from my wife to which Einstein replied is missing. The basic reason for the dispute between [Einstein and me] on the validity of statistical laws was as follows: Einstein was firmly convinced that physics can supply us with knowledge of the objectively existing world. Together with many other physicists, I have been gradually converted, as a result of experiences in the field of atomic quantum phenomena, to the point of view that this is not so. At any given moment, our knowledge of the objective world is only a crude approximation from which, by applying certain rules such as the probability laws of quantum mechanics, we can predict unknown (e.g. future) conditions.

Reference

1. M. Born, *The Born–Einstein Letters 1916–1955: Friendship, Politics and Physics in Uncertain Times*, Macmillan, New York (2005), p. 79. Letter © Hebrew University of Jerusalem.

When I arrived at Kodak in 1951 with a newly minted degree in physics, a number of my fellow workers and some of my bosses had begun their Kodak careers at Oak Ridge.

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Parkins replies: Henry F. Ivey asserts that the pinch effect in electron beams due to residual gas ionization was well known to many researchers including us at Cornell University. He states that it differs only in the trivial change of polarity, but there are other significant differences:

- The pinch effect is localized.
- It contains many small fields.
- A mass spectrometer cannot tolerate even slight space-charge repulsion.
- In the calutron's final design, the entire tank fills with a uniform equipotential plasma except for a thin sheath only a few volts positive relative to the tank wall.

This surprising natural process was totally unexpected. The Japanese gave up on even trying mass spectrometry, as did the Germans, because they did not believe that the space-