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This Week's Citation Classic®

Cherenkov P A. Visible light from clear liquids under the action of gamma radiation.
C.R. (Dokl.) Acad. Sci. URSS 2:451-4, 1934.
[Physico-Mathematical Institute V.A. Steklova, Academy of Science, Leningrad, USSR]

This paper reports observations of previously unknown properties of visible radiation produced in clear liquids under the action of fast electrons, such as beta-particles from radioactive elements or Compton electrons liberated in liquids in the process of scattering of gamma rays. These properties include the polarization of the radiation and the marked asymmetry of its emission directionality. [The *SCI*® indicates that this paper has been cited in more than 100 publications from 1945 to 1990.]

Faster Than a Speeding Photon

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It is an undue honor, but a pleasure nonetheless, that I should be invited to write this commentary. This material is based on: (a) a delightful surprise visit (I thought he was already long deceased) with P.A. Cherenkov in his laboratory in Troitsk (just south of Moscow) in 1979; (b) his personal reminiscences recounted in a historical review paper[1] he presented at a seminar, "Cherenkov Detectors and Their Applications in Science and Technics," celebrating the 50th anniversary of the Vavilov-Cherenkov radiation discovery; and (c) additional information supplied to me by one of Cherenkov's colleagues, Boris B. Govorkov, P.N. Lebedev Institute, who hosted me in Moscow in 1979.

Pavel Alekseevich Cherenkov, who died of yellow jaundice January 6, 1990, in Moscow, was born to a peasant family on July 28, 1904, in Voronezh, a city midway between Moscow and Rostov, on the Voronezh River, just before it flows into the Don. A graduate of Voronezh University, he did postgraduate work at the Physics Institute of the USSR Academy of Sciences, Moscow, from 1930 to 1935, from which he was awarded a doctorate in natural science in 1940.

During this period, under the guidance of S.I. Vavilov, Cherenkov investigated the luminescence of solutions of uranium salts under the action of gamma radiation. He observed, as reported in the 1934 "discovery" paper, that gamma radiation creates a weak luminescence of the solution, which differs sharply from normal luminescence. This observation stimulated his extensive further experiments, eventually defining the Cherenkov (or Cherenkov-Vavilov) effect and what we now know as Cherenkov radiation.

This radiation, seen but not explained by Marie Curie around the turn of the century, is the beautiful blue glow we see in the liquid surrounding strong gamma-ray or charged-particle emitters such as fuel rods in a swimming pool reactor. This 100 percent polarized light, emitted at an angle related by a simple formula to the particle velocity and the refractive index of the medium, is produced when energetic particles, such as Compton electrons, exceed the velocity of light, which is slowed in the clear liquid (or glass, or plastic, etc.) in proportion to the reciprocal of the refractive index.

A sound theoretical basis for the new radiation, as an electrodynamical analog to the Mach waves of hydrodynamics, was provided by I.M. Frank and I.E. Tamm[2] and quantitatively verified by Cherenkov's further experiments.[3,4] However, although the work was greeted enthusiastically by physics luminary Niels Bohr, Cherenkov's English-language manuscript, "Visible radiation produced by electrons moving in a medium with velocities exceeding that of light," was rejected by *Nature*, whose editors did not take the work seriously. The *Physical Review* was somewhat more open-minded and accepted the paper, which underwent only a change of mailing envelope, as a letter to the editor.[5]

In 1958, Cherenkov, Frank, and Tamm shared the Nobel Prize in physics "for the discovery and explanation of the Cherenkov effect." Cherenkov's numerous other awards and honors include the Order of Lenin (twice) and the State Prize of the Soviet Union (three times). Although he was not of great physical stature, Pavel Alekseevich Cherenkov casts a long shadow (or light, actually) across both the history and future of radiation physics.

1. **Cherenkov P A.** At the threshold of discovery. *Nucl. Instrum. Meth. Phys. Res. A* 248(1):1-4, 1986.
2. **Frank I M & Tamm I E.** Coherent visible radiation of fast electrons passing through matter. *C.R. (Doklady) Acad. Sci. URSS* 14:109-14, 1937. (Cited 55 times since 1945.)
3. **Cherenkov P A.** Visible light of pure liquids under the action of hard beta-radiation. *C.R. (Doklady) Acad. Sci. URSS* 14:101-5, 1937.
4. ---------. Angular dependence of the intensity of light emission, produced by gamma-radiation in pure liquids. *C.R. (Doklady) Acad. Sci. URSS* 14:105-8, 1937.
5. ---------. Visible radiation produced by electrons moving in a medium with velocities exceeding that of light. *Phys. Rev.* 52:378-9, 1937.

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