

# This Week's Citation Classic

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**Inokuti M.** Inelastic collisions of fast charged particles with atoms and molecules—Bethe theory revisited. *Rev. Mod. Phys.* **43**:297-347, 1971. [Joint Inst. Lab. Astrophys., Univ. Colorado and Natl. Bureau Standards, Boulder, CO; Argonne Nat. Lab., Argonne, IL]

Much of the cross-section data, theoretical and experimental, can be summarized efficiently from the point of view initiated by Bethe in 1930.<sup>1</sup> The paper describes this point of view, together with recent developments, and thus presents a basic framework for data analysis and evaluation in which the notion of the generalized oscillator strength plays a key role. [The SC<sup>®</sup> indicates that this paper has been cited over 335 times since 1971.]

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"In 1963 the late Platzman suggested that I study the Bethe paper<sup>1</sup> so that we could fully use the elements of the Bethe theory to analyze contemporary cross-section data for use in radiation physics. One motivation was the series of excellent experiments by Lassetre<sup>2</sup> and co-workers, who analyzed the energy and angular distribution of electrons scattered by an atom or molecule, and thereby obtained reliable differential cross sections for electrons of well-defined initial energies of several hundred eV. One reason I readily followed Platzman's suggestion was that I had learned German pretty well. It is a pity that younger physicists nowadays seldom study German. Reading the Bethe paper in the original form gave me great pleasure because of its precision and comprehensibility.

"As I studied the Bethe paper for several years, I became enchanted with it; it was indeed a gold mine of ideas, some of which resulted in papers with Platzman, Kim, and others. In 1968 I gave a seminar on the general topic at the University of Chicago, and later at the Joint Institute of Laboratory Astrophysics, University of Colorado. At Chicago, Fano liked my seminar and suggested that I write the study as an article for *Review of Modern Physics*. At Boulder,

Branscomb, who was the chairman of the Institute and also was serving as editor of *Review of Modern Physics*, suggested the same. (He is now the chief scientist of IBM.)

"But there is more to this story about the origin of the article. In the course of earlier work with Kim, it became clear that a set of cross-section data for electron detachment from the hydrogen negative ion by electron impact must be grossly incorrect in view of the Bethe theory. This set of data came from an experiment by Branscomb and his associate Tisone. I had correspondence with Branscomb about this and must have made him awfully concerned and worried. Graciously, he accepted my criticism and suggested that I come to his Institute as a visitor to write the article on the Bethe theory.

"Thus I went to Boulder in the fall of 1969 and wrote the article, at the same time giving a series of lectures on the topic. After the article was published, I enjoyed and was delighted to receive many requests for reprints; at last my supply became exhausted and I had to order reproductions of the article a few years later.

"Frequent quotation of my article, as seen in the *Science Citation Index*<sup>®</sup>, does not surprise me at all. The subject matter is important to many areas of research, such as radiation physics, plasma physics, electron microscopy, and space research. There were many fellow scientists who wrote to me to ask questions or to point out things I should have known. Among them, Turner and Itikawa taught me the most. So I decided to generate another article<sup>3</sup> that would supplement and update the earlier article, together with these two friends of mine.

"The real reason for frequent quotation is simple, but is no credit to me. The original work of Bethe is superb, and I only para-phrased his ideas using contemporary data and pointing out recent developments. Indeed, Bethe himself considers the 1930 paper the best he has ever written, according to the recent biography written by Bernstein.<sup>4</sup> The most incredible thing to me is that he wrote that great paper at the age of 24."

1. **Bethe H.** Zur Theorie des Durchgangs schneller Korpuskularstrahlen durch Materie. *Ann. Phys.* (Leipzig) **5**:325-400, 1930.
2. **Lassetre E N.** Inelastic scattering of high energy electrons by atmospheric gases. *Can. J. Chem.* **47**:1733-74, 1969.
3. **Inokuti M, Itikawa Y & Turner J E.** Addenda: inelastic collisions of fast charged particles with atoms and molecules—the Bethe theory revisited. *Rev. Mod. Phys.* **50**:23-35, 1978.
4. **Bernstein J.** Profiles. Master of the trade. *New Yorker* **55**(42):50-106, 1979.