

Porod G. Die Röntgenkleinwinkelstreuung von dichtgepackten kolloiden Systemen. I. Teil. (X-ray low angle scattering of dense colloid systems. Part I.) *Kolloid-Zeitschrift* 124:83-114, 1951.
[Institute of Theoretical and Physical Chemistry, University of Graz, Austria]

The paper presents a general theory of X-ray scattering from colloid systems including interparticle interference. The special case of micellar systems is treated in more detail. It could be shown that some characteristic parameters such as the colloid surface, an average volume, and an average length can be determined from experimental scattering data. All of the information available from experiment is expressed by a characteristic (correlation) function. [The *SCI*[®] indicates that this paper has been cited in over 390 publications since 1961.]

Günther Porod
Institute of Experimental Physics
Karl-Franzens-University of Graz
A-8010 Graz
Austria

July 12, 1982

"By 1950, X-ray scattering of particles in dilute solutions was fairly well understood and widely used. It was also obvious that with higher concentration, and more so in densely packed systems, interparticle interference must play an important role. But there was no theoretical approach to this question, and there was even controversy as to its bearing on the experimental data. So here seemed to be an interesting and promising problem to explore when I decided to write my *Habilitationsarbeit* (a paper required to obtain the degree of *Dozent*). The choice of the topic was facilitated by the fact that I was then working as assistant in the institute of O. Kratky, the leading expert in the field of X-ray small angle scattering. I am much indebted to his stimulating influence. After half a year's hard work, the work was finished. But when I submitted the paper to *Kolloid-Zeitschrift*, I was told that it was too voluminous for publication as a whole. So it had to be split into two parts, Part I being the paper cited here. Part II did

not attract as much attention because the ideas developed there concerning highly disordered colloid structures are of more theoretical than practical interest.

"The fundamental point of the problem was the question: what information about the structure is contained in the experimental scattering curve? The clue to this was found when it occurred to me that all that information could be expressed by one single characteristic function, a sort of correlation function. From this starting point it was rather easy to derive some characteristic parameters, and to show how these might be determined from experimental data. A certain integral, then termed the invariant of the system, proved to be of special value and was widely used afterward. Its importance rests on the fact that it is related directly to the electron density fluctuation irrespective of special structural features. So it can be used to eliminate scattering power and to avoid the difficult and inaccurate measurement of absolute intensity. A further result, which found some attention afterward, was a formula connecting the slope of the scattering curve with the colloid surface. The level of experiment was not accurate enough in 1951 to make practical use of the formula, so it seemed to be of mere theoretical interest. But experimental equipment soon improved and the formula became the basis of a standard method for the determination of the colloid surface. The ideas developed in this paper remain valid up to now. Of course, they could be refined and extended as shown by subsequent publications. The most recent review can be found in the book edited by O. Glatter and Kratky on small angle X-ray scattering.²

"Personally, I would stress the theoretical concepts as the most remarkable achievement of this paper. But I guess that the real reason why it has become a *Citation Classic* is that the results are directly applicable to experimental data. In colloid science effective methods are rare, as compared to other fields of research, and therefore attract more attention. I should add that this paper was also the main reason for my being awarded the Rudolf-Wegscheider-Prize (1954) by the Austrian Academy of Sciences."

1. Porod G. Die Röntgenkleinwinkelstreuung von dichtgepackten kolloiden Systemen. II. Teil. *Kolloid-Zeitschrift* 125:51-7; 108-22. 1952.
[The *SCI* indicates that this paper has been cited in over 145 publications since 1961.]
2. General theory. (Glatter O & Kratky O, eds.) *Small angle X-ray scattering*. London: Academic Press, 1982. p. 17-51.