

**Bjerrum J.** *Metal ammine formation in aqueous solution: theory of the reversible step reactions.* Copenhagen, Denmark: P. Haase and Son, 1941. 296 p.  
[Chemical Dept., Univ. Copenhagen, Copenhagen, Denmark]

Besides giving a general treatment of equilibrium systems in which a metal ion stepwise binds up to six ligands, this publication deals with the complex formation between metal ions and ammonia and ethylenediamine. The experiments are chiefly based on pH measurements with the glass electrode. [The SCI® indicates that this book has been cited in over 955 publications since 1961.]

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April 23, 1982

"In 1927, when I was 18 years old, I started studying intensely blue copper ammonia solutions. I found that in the presence of ammonium salt in high concentration it was possible to make homogeneous solutions also at small ammonia concentrations. I then began to study the equilibrium conditions in these solutions. This was done by measuring the very small ammonia vapour pressures over the solutions. A salt medium, 2 M ammonium nitrate, was used which at the same time constituted a constant salt medium. In this way I obtained the average number of ammonia molecules bound per copper atom (now internationally well known as  $\bar{n}$ ) as a function of the free concentration of ammonia. An analysis of the data showed the existence of all the intermediate complexes up to the pentammine complex and that the consecutive formation constants could be determined. The copper ammine work was published in German by the Danish

Academy of Science and Letters during the years 1931-1934<sup>1-3</sup> and is, for this reason, not as well known as my later work.

"In 1934, I obtained a Rockefeller Fellowship to study with Leonar Michaelis at the Rockefeller Institute for Medical Research in New York. In his laboratory I became acquainted with Mac Innes's glass electrode and realized that this electrode would be ideal for complex chemical studies. This aroused in me a strong wish to take up my former work again, and with the kind permission of Michaelis I was allowed to continue my own studies on metal ammine formation. The work was continued after my return to Denmark and published as my *Habilitations-schrift* in the beginning of 1941 during the German occupation of Denmark. I succeeded, however, in sending about 50 copies to the US before Pearl Harbor and the monograph was reviewed at length in *Chemical Abstracts*.<sup>4</sup> This has surely contributed to its being rapidly recognised as an important publication. Besides giving a large body of data, fundamental formulae, and general methods for treating complex systems with monodentate ligands, this publication also opened the field of quantitative chelate complex formation with ethylenediamine as an example. Contributions to the chemical terminology were also given.<sup>5</sup> *Metal Ammine Formation* was reprinted by Haase and Son in 1957, and a Russian edition appeared in 1961. The monograph has given inspiration to numerous chemists, many of whom have during the years worked with me in Copenhagen. My data can be found in many Who's Who publications and recently in *Marquis' Who's Who in the World*."

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2. -----, Untersuchungen über Kupferammoniakverbindungen. II. *Mat. Fys. Medd. Dan. Vid. Selsk.* 11:1-64, 1932.
3. -----, Untersuchungen über Kupferammoniakverbindungen. III. *Mat. Fys. Medd. Dan. Vid. Selsk.* 12:1-67, 1934.
4. McReynolds J P. Review of *Metal ammine formation in aqueous solution: theory of the reversible step reactions* by J. Bjerrum. *Chem. Abstr.* 35:6527-34, 1941.
5. Brock W H, Jensen K A, Jørgensen C K & Kauffman G B. The origin and dissemination of the term "ligand" in chemistry. *Ambix* 27:171-83, 1981.