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## DIPOLE ATTRACTION AND HYDROGEN BOND FORMATION IN THEIR RELATION TO SOLUBILITY\*

By Professor JOEL H. HILDEBRAND

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THE germ of the idea of a hydrogen bond may be seen in some of the formulas of Werner involving covalent linkage; however, he avoided committing himself concerning the nature of this linkage, which was little more than a dotted line, and very different from its modern significance of a definite electron pair bond. Moore and Winmill,<sup>1</sup> in 1912, wrote formulas containing light and heavy lines to account for the weakness of trimethyl amine in aqueous solution,  $(\text{CH}_3)_3 \equiv \text{N}-\text{H}-\text{OH}$ , as compared with tetramethyl ammonium hydroxide,  $(\text{CH}_3)_4 \equiv \text{N}-\text{OH}$ . The former may be interpreted as the first definite repre-

sentation of a hydrogen band. In the following year Pfeiffer<sup>2</sup> suggested as an explanation of the weakness of o-hydroxyanthraquinone that the hydrogen atom is "coordinately" bound to the oxygen atom of the adjacent carbonyl group. The first recognition of the hydrogen bond as a general phenomenon we owe to Latimer and Rodebush.<sup>3</sup> They called attention to the effects of hydrogen bond formation, such as the high dielectric constant of water, which ordinary dipoles do not show. Lewis<sup>4</sup> cited the existence of  $\text{HF}_2^-$  but not  $\text{F}_2^{--}$  as offering direct evidence of a hydrogen bond. The unusual properties of ammonia, water

\* Address of the vice-president and chairman of the Section of Chemistry, American Association for the Advancement of Science, St. Louis, December, 1935.

<sup>1</sup> T. S. Moore and T. F. Winmill, *Jour. Chem. Soc., London*, 101: 1675, 1921.

<sup>2</sup> P. Pfeiffer, *Ann.*, 398: 137, 1913.

<sup>3</sup> W. M. Latimer and W. H. Rodebush, *Jour. Am. Chem. Soc.*, 42: 1419, 1920.

<sup>4</sup> G. N. Lewis, "Valence," p. 109, Chemical Catalog Company, 1923.

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