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MISSED OPPORTUNITIES[1]

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> It is important for him who wants to discover not to confine himself to one chapter of science, but to keep in touch with various others.
> JACQUES HADAMARD

1. **Introduction.** The purpose of the Gibbs lectures is officially defined as "to enable the public and the academic community to become aware of the contribution that mathematics is making to present-day thinking and to modern civilization." This puts me in a difficult position. I happen to be a physicist who started life as a mathematician. As a working physicist, I am acutely aware of the fact that the marriage between mathematics and physics, which was so enormously fruitful in past centuries, has recently ended in divorce. Discussing this divorce, the physicist Res Jost remarked the other day, "As usual in such affairs, one of the two parties has clearly got the worst of it." During the last twenty years we have seen mathematics rushing ahead in a golden age of luxuriant growth, while theoretical physics left on its own has become a little shabby and peevish. So I am forced to give this lecture an emphasis different from that intended by the founders. Instead of talking about "the contribution that mathematics is making to present-day thinking" in my field, I shall talk about the contribution that mathematics ought to have made but did not. I shall examine in detail some examples of missed opportunities, occasions on which mathematicians and physicists lost chances of making discoveries by neglecting to talk to each other. My purpose in calling attention to such incidents is not to blame the mathematicians or to excuse the physicists for our failure in the last twenty years to equal the great achievements of the past. My purpose is not to lament the past but to mould the future.

It is obviously absurd for me to imagine that I can mould the future with a one-hour lecture. The fact that Hilbert in 1900 [1] and Minkowski in 1908 [2] succeeded in doing it does not give me any confidence that I can do it too. But at least I have learned from Hilbert and Minkowski that one does not influence people by talking in generalities. Hilbert and Minkowski gave specific suggestions of things that mathematicians and physicists could profitably think about. I shall try to follow their

[1] Josiah Willard Gibbs Lecture, given under the auspices of the American Mathematical Society, January 17, 1972; received by the editors January 17, 1972.