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ANALYTIC EXTRAPOLATION TECHNIQUES AND STABILITY PROBLEMS IN DISPERSION RELATION THEORY

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Abstract:

The point we try to make is that in an indirect science like elementary particle physics, it is not sufficient to have a specific description of the world brought by some happy inspiration, but rather it is necessary to optimize among large classes of (preferably among all) possible equivalent revelations. Indeed, although the leading concepts of which every description of nature makes use should bear a very close relation to the experimentally accessible data, in those situations when the basic laws are inherited from other fields, their concepts may prove to be very remote from experiment, and to "measure" them one might have to go through wildly unstable inverse problems (ill posed problems in the Hadamard sense). Moreover, the instabilities of the inverse laws become especially dangerous when the "direct laws" are too smooth, as it happens in particle physics whenever we try to cling to classical concepts (Lagrangians, interaction terms, etc.) which were purposedly chosen to produce "good" classical physics laws.

To cope with this situation, one has *first* to introduce some new (experimentally or theoretically measurable) quantities, extraneous to the inherited theory, with the purpose of delimiting some compact sets inside which stable solutions of the inverse problems can be sought. Then, once the whole problem has been stabilized, there appears a *second* reason for a rational strategy of concepts and approaches, since mathematically equivalent descriptions are often rendered inequivalent by the ever existing regions where experimental knowledge lacks or is incomplete. As we try to argue in section 3, this breaking of tautologies is due to the fact that the randomness of ignorance destroys just those delicate mathematical properties (like, for instance absolute analyticity of the input) which had rendered the methods equivalent in the ideal case of total knowledge. Therefore it is of practical relevance to find among all the previous tautologic methods, that one which is least affected by our limited amount of knowledge.

This paper treats the incidence of these questions in some theoretical and phenomenological problems of particle physics, in which analytic continuation is used at least as an intermediate step.

Contents: