'FAQ' Modeling of Tensor Fields, Part I: Context, and General Considerations*

A. R. Jadhav† and S. R. Kajale
College of Engineering (COEP), University of Pune, India
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The acronym 'FAQ' stands for Fields As Quanta—a new conceptual and computational approach being developed by us ab initio. The basic idea here is to take any classical field pattern and think of it as if a large collection of tiny quanta had gone into producing it. Thinking along these lines, initial success was obtained for a certain mathematical class which we have named as "Helmholtzian"—i.e., the linear wave (hyperbolic), heat/diffusion (parabolic) and Poisson-Laplace (elliptic) equations, all taken together in a single class.

For the Helmholtzian class, the reinterpreted Huygens process provides the mechanism with which the spatially spreading field can be constructed. This process is notably different from both Green's functions and Feynman's propagator formalism. By probabilistically sampling the surface of the isotropic Huygens wavelet, a computational method to construct the field is obtained. Thus, the Monte Carlo technique is an implication—not a starting point—in the FAQ approach.

Indeed, taken in an abstract sense, the Huygens process can serve as a template to construct even more complex fields. Accordingly, we have been looking at the possibility of formulating a FAQ view of tensor fields. However, the development of such a view still remains a matter of conjecture. In this paper, we state the conjecture itself in words, i.e., in informal but precise terms.

The paper begins by noting down the equations of elasticity because it is the simplest example of a completely specified stress field system. We mention the three fundamental problems of elasticity as the devices that allow simplification via boundary conditions, without reducing the order of the tensor. Accordingly, developing a FAQ view for only the first fundamental problem should be sufficient.

We then identify the existence of the differential coupling as the basic reason why the general 3D stress field problem is difficult to solve. We show how the basic solution strategy has always been to make the coupling implicit by reformulating the problem—whether by using the stress- and potential-functions as in the analytical methods, or via weak reformulations as in FEM and BEM. We also briefly discuss why problem reformulation is not desirable.

We then provide a review of the very limited prior work that has attempted to give a stochastic view of elasticity. This review makes it possible to see how and why our conjecture is both unique and novel.

Finally, we point out how the problems of plane elasticity can be solved using the already developed techniques of FAQ.

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†Electronic address: ToneBrush@vsnl.net