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The mathematics and mechanics of bodies described by implicit constitutive equations

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Abstract. After first discussing the need for implicit constitutive relations to describe the response of both solids and fluids, I will then discuss applications wherein such implicit constitutive relations can be gainfully exploited. It will be shown that such implicit relations can explain phenomena that have hitherto defied adequate explanation such as fracture and the movement of cracks in brittle solids, the response of biological matter, and colloidal solutions. They also provide a new way to look at numerous non-linear phenomena exhibited by fluids and present a totally new and innovative way to look at the problem of Turbulence. The theory naturally leads to interesting new systems of partial differential and integro-differential equations that present challenges in both abstract and numerical analysis. Implicit constitutive relations also lead to characterizations of responses in terms of maximal monotone graphs that lead to challenging mathematical questions.