Structure-preserving integrators for smooth and non-smooth thermomechanical problems

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There has been a large amount of work on structure-preserving numerical methods in mechanics, mostly applied to Hamiltonian problems. However, many problems of interest in this field are not Hamiltonian, since they include dissipative mechanisms.
For a general class of dissipative problems though, the ones possessing a thermodynamic structure, it is possible to devise numerical methods that preserve it, yielding approximations that are strictly energy-conserving and entropy non-decreasing, for closed systems. The solutions obtained in this fashion give accurate pictures of the dynamics of the underlying problem, and often result in robust numerical schemes.
In this talk we will describe this kind of numerical approximations in the context of smooth problems [1] and present new results for non-smooth ones. The latter can be employed, for example, to construct thermodynamically consistent integrators for thermoplasticity, but are general enough to encompass other cases of interest.

References

[1] I Romero. Thermodynamically consistent time stepping algorithms for nonlinear thermomechanical systems. *International Journal for Numerical Methods in Engineering*, 79(6):706–732, 2009.