Doctoral Thesis of Adam Janecka

Thesis is well organized and well written. The subject is very interesting and timely. The main results are: (i) a new physical interpretation of Rajagopal's viewpoint of constitutive relations in hydrodynamics, (ii) the associated with it extensions of Rajagopal's viewpoint, (iii) consequences.

(i) In the context of the extended hydrodynamics in which the stress tensor $\mathbb{T}$ is adopted as an independent hydrodynamic variable, Rajagopal's viewpoint emerges as a consequence of the physical requirement of the compatibility of the extended and the classical hydrodynamics (i.e. it expresses the passage $EH \to CH$).

(ii) Three extensions of Rajagopal's viewpoint arise. The first one is the equation governing the time evolution of $\mathbb{T}$ expressing the compatibility with CH (the potential generating this time evolution is the potential that is maximized in Rajagopal's formulation). The second is the formulation of the extended hydrodynamics (i.e. the time evolution equations for $(\boldsymbol{u}, \mathbb{T})$ that express the passage $EH \to E$) that can also be seen as a two stage passage $EH \to CH \to E$, where the first stage $EH \to CH$ is the one appearing in the first extension. The third extension is the realization that it is not only $\mathbb{T}$ that can play the role of the extra state variable in the extended hydrodynamics. Other candidates are conformation tensors and various distribution functions.

(iii) The notion of CR-instability is introduced. Other consequences which the author may explore later are for example: (a) Stability discussed in Section 4 can be extended to include the CR stability. In other words, stability can be investigated in the setting in which $(\boldsymbol{u}, \mathbb{T})$ evolve in time (from the physical point of view, the fluid in such setting is not only non-Newtonian but also elastic). (b) In the context of the non-convexity of the generating potentials and the corresponding to it S-shape type solutions, it should be interesting to make always systematically two formulations, the first is Rajagopal's type formulation expressing $EH \to CH$ and the second is the corresponding to it extended hydrodynamics expressing $EH \to E$. The generating potentials are different in the two formulations. Where does the non convexity appear in them? For example, the model presented in Section 6.4.2 is formulated as the extended hydrodynamics expressing $EH \to E$. What is the corresponding to it $EH \to CH \to E$ formulation? Where is the nonconvexity in the generating potentials? (c) In the numerical calculations (in discretizations) one should not forget about the requirement of the compatibility with thermodynamics. The discretized formulation should keep the mathematical structure guaranteeing the compatibility,

Thesis demonstrates the mastery of the subject and creative thinking. The author takes a very familiar to him subject (Rajagopal's theory) and sees it differently. I recommend the acceptance of the Thesis

P.S. It would be useful if in the list of notations were included also the acronyms (as Ch,CT,E, GENERIC, CR-GENERIC,...)