Radiative heat transfer of Reiner–Philippoff fluid flow past a nonlinearly shrinking sheet: Dual solutions and stability analysis

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ABSTRACT

The non-Newtonian fluid model is developed to counter the limitation of the classical model (Newtonian) where it reflected the real fluid flow behaviour arising in industrial application and to improve operational efficiency. Out of many existing models representing the non-Newtonian fluid type, the Reiner-Philippoff model is of concern due to its ability to capture few properties in certain cases. Hence, the current study attempts to analyse the heat transfer of Reiner–Philippoff fluid flow past a nonlinearly shrinking sheet with the impact of thermal radiation. By adopting appropriate transformations, the partial derivatives of multivariable differential equations are reduced to ordinary differential equations of a specified form. The resulting mathematical model is solved in the MATLAB software using the bvp4c technique. The outcomes show the improvement in the friction factor for the shrinking sheet, whereas reversed behaviour is observed for the stretching sheet. Meanwhile, high vorticity occurs over a shrinking sheet which led to a reduction of the heat transfer rate. The addition of the Reiner–Philippoff fluid parameter lowers the friction factor while the heat transfer rate is increased along with the stretching sheet, while it is decreased for the shrinking sheet. Also, the escalation of the radiation parameter causes more radiative heat energy to be pumped into the flow field that raising the temperature but reducing the heat transfer rate. It is also revealed that the manifestation of suction is one of the factors that contributed to instituting the dual solutions. The dual solutions are established, which leads to the implementation of stability analysis that backs up the validity of the first solution.

KEYWORDS

Reiner–Philippoff fluid; shrinking sheet; heat transfer; stability analysis; dual solutions; thermal radiation

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