

Modifications on Laminar Premixed Flame Dynamics. Symmetries and Solutions

VOLKMANN, JOERG¹ AND BAUMANN, GERD²

Department of Mathematical Physics,
University of Ulm,
Albert-Einstein-Allee 11,
D-89069 Ulm,
Germany

e-mail: ¹ Jo.Volkman@fh-wolfenbuettel.de,
² gerd.baumann@physik.uni-ulm.de

Power production by combustion is one of the oldest techniques of mankind. Approximately 90% of our current power requirement are based on combustion processes. To describe the phenomenon of combustion processes equations of fluid mechanics and chemical physics are applied ([1]). Recently equations of the form

$$\begin{aligned} a \frac{\partial T}{\partial t} - \Delta T &= bC \exp\left(-\frac{E}{RT}\right) \\ \frac{\partial C}{\partial t} - \Delta C &= fC \exp\left(-\frac{E}{RT}\right) \end{aligned} \tag{1}$$

are investigated in the paper [2]. Additionally similar systems are considered in a lot of papers (f. e. [3, 4, 5, 6]). The application of symmetry methods shows that the system of equations (1) can be simplified to the form

$$\begin{aligned} a \frac{\partial T}{\partial t} - \Delta T &= bC (A - C) \\ \frac{\partial C}{\partial t} - \Delta C &= fC (A - C) \end{aligned} \tag{2}$$

In our presentation the group analysis approach is applied to the system of equations (2). Therefore the symmetry algebra and their properties are discussed. Additionally the optimal system is presented and solutions are given. Some generalizations are also discussed.

References

- [1] J. Warnatz, U. Maas, R. W. Dibble, *Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation*, 4th edition, Springer, 2006

- [2] J. Volkmann, G. Baumann, *New results of reactive Navier–Stokes equations*, Proceedings of the International Conference of Modern Group Analysis MOGRAN, ed. V. A. Baikov, R. K. Gazizov, N. H. Ibragimov, F. M. Mahomed, Ufa 2000
- [3] J. Erlandsson, *Survey of mathematical models in biology from point of view of Lie group analysis*, Archives of ALGA, Ed. N. H. Ibragimov, Vol. 2, 45 - 122, 2005
- [4] V. A. Baikov, A. V. Gladkov, R. J. Wiltshire, *Lie Symmetry classification analysis from non-linear coupled diffusion equation*, J. Phys. A: Math. Gen. 31 (1998), 7483 - 7499
- [5] J. Lang, B. Erdmann, R. Roitsch, *Three-Dimensional Fully Adaptive Solution of Thermo-Diffusive Flame Propagation Problems*, Preprint of the Konrad-Zuse-Centrum, SC97-18 (April 1997)
- [6] J. H. M. ten Thije Boonkamp, L. P. H. de Goey, *A flamelet model for premixed stretched flames*, win.tue.nl/pub/local/new...rana9907.ps