Analytical modelling of species and energy transport from evaporating drops

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Tuesday, February 28, 2023; 09:30-11:30, Room Pfaf31_1.103

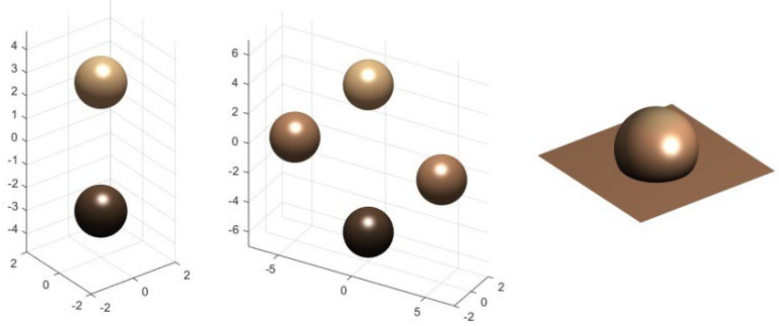
Analytical modelling of heating and evaporation of drops in gaseous environment is usually tackled starting from the species, energy and momentum conservation equations and introducing simplifying assumptions to yield a set of differential equations that may admit analytical solutions.

The lecture is will describe two general approaches to model the energy and mass transport from single component and multi-component drops. The first part will describe a general method to solve the set of non-linear PDEs that describe the quasi-steady transport through the gas phase of energy and species from a single component-evaporating drop of general shape. The approach accounts for the effect of temperature gradients in the gas phase, and the analytical solution to the problem can be obtained taking into account the temperature dependence of the gas mixture thermo-physical properties (mixture density, thermal conductivity, specific heat and diffusion coefficients). The second part will deal with a method to model the mass and energy transport from a multi-component evaporating drop, based on the analytical solution of the Stefan-Maxwell equations. Also in this case, the method can be applied to drops of any shape.

Time schedule of the seminars:

1. Analytical modelling of quasi-steady evaporation of a single component drop in high temperature environments (1h).

2. Modelling of quasi-steady evaporation of multi-component drop of any shape through the analytical solution to the Stefan-Maxwell equations. (1 h).



Orthogonal curvilinear coordinate systems in analytical modelling of drop evaporation

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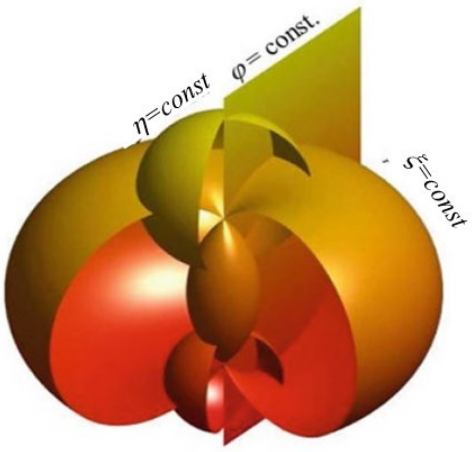
Tuesday, February 28, 2023; 13:30-15:30, Room Pfaf31_1.103

Orthogonal curvilinear coordinates occupy a special place among general coordinate systems, due to their special properties. There exists a number of such coordinate systems where the Laplace or Helmholtz equations may be separable, thus yielding a powerful tool to solve them. Analytical modelling of quasi-steady heating and evaporation of single and multi-component drops is often based on solutions to the Laplace equation, and the choice of proper curvilinear coordinate systems can strongly simplify the modelling, allowing in some case one-dimensional or two-dimensional analytical forms of vapour and temperature distribution in the gas mixture.

The lecture will first introduce the main properties of orthogonal curvilinear coordinate systems, in a way to allow simple application to practical cases. Then some special cases, where the proper choice of a curvilinear coordinate system allows simple solutions, will be described, referring also to some recent results. Some applications to the evaporation of oscillating drops, interaction between neighbouring drops, evaporation of sessile drops, etc. will be described in the framework of curvilinear coordinate systems.



Bispherical coordinate system

Time schedule of the seminars:

1. Introduction to orthogonal curvilinear coordinates and their properties, with applications to simple cases of evaporating drops (1h).

2. Use of some special curvilinear coordinate systems in modelling the evaporation of single component and multi-component drops (1h).