Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

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German Academic Exchange Service

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DLR – DAAD Fellowships

Fellowship No. 399

Research Area : **Space**

Research Topic: **Atomic Emission Spectroscopy in High Enthalpy Flows**

DLR Institute: **Instiute of Aerodynamics and Flow Technology, Department Spacecraft, DLR Göttingen**

Position: Postdoctoral Fellow

Openings: 1

Job Specification: The thermochemical state of the shock layer surrounding hypersonic vehicles has a major impact on the macroscopic flight parameters of flight. The shock layer is the interface between the vehicle and the atmosphere, and creates structural and heating loads and imposes external forces which may be advantageously used for control, propulsion and deceleration purposes if properly understood, modelled and analysed. If not properly controlled, vehicle survival is threatened, and so it is an essential issue to be addressed. Some of the critical and less understood issues involve the levels of post shock dissociation of O_2 and N_2, the formation of diatomic radicals such as CO and NO, and the non-equilibrium levels of vibrational and electronic excitation of the critical species, and the associated radiation emitted from the shock layer. These non-equilibrium conditions can persist in the boundary layer, and through the effects of recombination and surface catalicity enhance the heat transfer to the vehicle. This generic phenomenon is the focus of an ongoing research project at the German Aerospace Center (DLR. The High Enthalpy Shock Tunnel Göttingen (HEG) of the DLR, operated by the Department Spacecraft of Institute of Aerodynamics and Flow Technology, is one of the major European hypersonic test facilities. HEG was commissioned for use as a free piston driven shock tube in 1991 and has been extensively utilized since then in a large number of national and international space and hypersonic flight projects. The facility is an impulse facility providing unique capabilities to reproduce the high total pressure and high velocity flows which are associated with scramjet-powered access to space and planetary re-entry trajectories. These flows can be used for aerothermodynamic studies to improve physical models of the flow around hypersonic vehicles, to develop and validate computational fluid dynamics (CFD) codes and to verify design concepts prior to flight testing. Emission spectroscopy uses quantitative measurements of the optical emission from hot gases. The wavelengths emitted are unique to each atom, ion or molecule present and may be examined using a spectrograph and a detector. The wavelengths seen in the spectrum indicate what atoms are present. The intensity of the light emitted by the hot gas is proportional to the concentration of the emitting species for low density flows; hence quantitative analysis of the hot gas is possible. The application of the emission spectroscopy technique at DLR in HEG is in its beginning state, a few feasibility studies have been performed. The work to be fulfilled by the candidate is to investigate the hypersonic flow around a two dimensional wedge, which at selected angles of attack is a useful platform for parametric variations of gas composition. The flow/model will be investigated in cooperative work with the University of Queensland (UQ) sharing experiences of the emission spectroscopy measurement system of UQ. Based on the findings, the existing emission spectroscopy system of DL will be refined and extended to be applicable to the simulation envelope of HEG. Shock tunnels are known to contain contaminants from residual diaphragm materials, substances adhering to the walls which get entrained in the shock heated flows, and metallics from the walls of the stagnation regions of reflected shock tunnels. These can significantly affect total heat transfer in the stagnation regions of shock tunnel models, and also corrupt the interpretation spectral measurements when the contaminant’s radiative signature overlaps critical spectral regions of the species being studied. During the initial phase it is proposed to do a series of blunt body experiments to quantify the contaminating species and their concentrations before proceeding to the inclined wedge experiments.

Required Qualification:

- PhD degree in physics or similar discipline
- Excellent analytical skills
- Solid programming experience in high-level
- Very good knowledge of fluid mechanics, chemistry of reacting gases, radiation of plasmas and heat transfer
- Ability to work in a structured way both, independently and as part of a team

Advantageous Skills:

- Experience in Signal Processing and Image Processing
- Experience with free piston driven shock tubes
- Strong interest in experimental/optical experimental testing of high enthalpy short duration hypersonic flows

English competence: See requirements on www.daad.de/dlr

Earliest Start Date: 1st of October 2019
1

Application Deadline: until position filled

Further Information: http://www.dlr.de http://www.daad.de/dlr