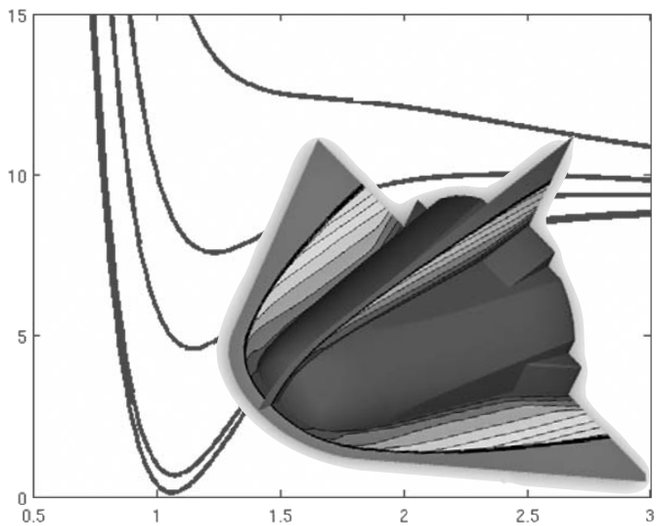
von KARMAN INSTITUTE FOR FLUID DYNAMICS

Non-Equilibrium Gas Dynamics from Physical Models to Hypersonic Flights

RTO - AVT / VKI LECTURE SERIES



September 8-12, 2008

In collaboration with the RTO

NATO RESEARCH AND TECHNOLOGY ORGANIZATION

von Karman Institute for Fluid Dynamics
72, Chaussée de Waterloo
1640 Rhode-Saint-Genèse, Belgium

Phone: +32(0)2 359 96 04 - Fax: +32(0)2 359 96 00
E-mail: secretariat@vki.ac.be, TVA BE 0407 185 709
Website: http://www.vki.ac.be

INTRODUCTION

Development of hypersonic flights for aerospace transport industry, space agencies, and defense programs requires in-depth knowledge of non-equilibrium gas dynamics effects for accurate design and safe operation of spacecraft, planetary probes, and rockets. The transport of mass, momentum, and energy in flows in thermo-chemical non-equilibrium involves kinetic processes at a microscopic level and relies on the set-up of fine experimental apparatus and development of physical models built and elaborated in response to the needs of the aerospace community.

The objectives of this special course are to review the up-to-date theoretical models describing non-equilibrium effects, experimental techniques, as well as the numerical simulation strategies specific to aerothermochemisty. In particular, we will focus on better predicting the thermal loads on atmospheric entry bodies.

The introduction will deal with the thermo-chemical non-equilibrium models for gas dynamics and databases for kinetic mechanism and radiation phenomenon. Next, a section devoted to optical measurements in plasmas, such as those obtained for instance in shock tube facilities, will illustrate how to validate the theoretical models. Finally, we will integrate the non-equilibrium effects in applications for engineering design by means of numerical simulations.

The Directors of this Lecture Series are Professor O. Chazot from the von Karman Institute and Dr. T. Magin from Stanford University.

TIMETABLE

MONDAY SEPTEMBER 8, 2008

09:15 **Welcome address**
Prof. M. Carbonaro, von Karman Institute for Fluid Dynamics, Belgium

09:15 **Irreversible thermodynamics and non-equilibrium effects in hypersonic flows**
Dr. D. Giordano, European Space Research and Technology Centre, The Netherlands

11:00 **Kinetic theory of plasmas**
Dr. T. E. Magin, Stanford University, USA

14:00 **Kinetic theory of reactive molecular gases**
Prof. R. Brun, University of Marseille, France

15:45 **Electronically excited states and their role of affecting thermodynamic and transport properties of thermal plasmas**
Prof. M. Capitelli, University of Bari, Italy

17:00 **Reception**

TUESDAY SEPTEMBER 9, 2008

09:00 **Dissociation cross sections and rates for nitrogen**
Dr. D.W. Schwenke, NASA Ames Research Center, USA

10:45 **Electron impact excitation and ionization in air**
Dr. W. Huo, Huo Consulting LLC, USA

14:00 **Electronic excitation in air and carbon dioxide gas**
Prof. S.T. Surzhikov, Russian Academy of Sciences, Russia

15:45 **Vibrational energy exchange and nonequilibrium chemical reactions at high temperatures**
Dr. S. O. Macheret, Lockheed Martin Corporation, USA

WEDNESDAY SEPTEMBER 10, 2008

09:00 **Shock tubes and shock tunnels: design and experiments**
Prof. R. Brun

10:45 **Shock tube experiments for Earth and Mars entry conditions**
Dr. D. Bogdanoff, NASA Ames Research Center, USA

14:00 **Optical measurements in plasmas and nonequilibrium flows**
Prof. W. Lempert, Ohio State University, USA

15:45 **Radiation database for Earth and Mars entries**
Dr. M.Y. Perrin, CNRS, Ecole Centrale Paris, France

THURSDAY SEPTEMBER 11, 2008

09:00 **Collisional-radiative modeling in flow simulations**
Mr. M. Panesi, von Karman Institute for Fluid Dynamics, Belgium

10:45 **Radiation modeling in shock tubes and entry flows**
Prof. S.T. Surzhikov

14:00 **Quantification of uncertainty in flow simulations using probabilistic methods**
Prof. G. Iaccarino, Stanford University, USA

15:45 **Frontiers of aerothermo-dynamics**
Prof. C. Park, Advanced Institute of Science and Technology, Korea

FRIDAY SEPTEMBER 12, 2008

09:00 **Computational fluid dynamics simulations for atmospheric entries**
Prof. G. Candler, University of Minnesota, USA

10:45 **Computational fluid dynamics simulations for atmospheric entries (Continued)**
Prof. G. Candler

14:00 **Direct simulation Monte Carlo for atmospheric entry: I. Theoretical basis and physical models, II. Code development and application results**
Prof. I. Boyd, University of Michigan, USA

17:00 **VKI bus departure**

COURSE FEE

The course fee of 890 € includes printed notes, transport between VKI and the recommended hotels, lunches, beverages, and administrative costs. The prices include VAT (21%).

FELLOWSHIPS

To encourage greater participation in our Lecture Series programme by university members, the Institute has established a limited number of VKI Lecture Series fellowships for citizens of NATO countries contributing to the financing of the VKI, as well as for citizens of other NATO countries coming from a university in a VKI financing country. The recipient of a fellowship is entitled to attend the VKI Lecture Series at a reduced fee, which will be 595 € (VAT included) for assistants not having a Ph.D. degree and for Ph.D. candidates, or 295 € (VAT included) for undergraduate students. The request to be considered for an award must accompany the application to attend the Lecture Series, and the applicant must provide a recommendation letter from his or her professor; if not done so, the request will not be taken into consideration. All possible alternative sources of funding should be investigated before aid is requested under this scheme, so that those most in need will benefit.

METHODS OF PAYMENT

Payment 2 weeks prior to the beginning of the course (name and course title clearly indicated) by bank transfer to our account Nr 210-0315330-35 at Fortis Bank, avenue de la Forêt de Soignes 322, 1640 Rhode-Saint-Genèse, Belgium, IBAN BE57 2100 3153 3035 (strongly recommended). SWIFT BIC GEBA BE BB.

Late registration can be paid in cash (EURO), or by VISA or Eurocard at the beginning of the course.

PROCEEDINGS

Lectures will be given in English and printed notes will be distributed during registration. Proceedings of other non-RTO lecture series may be purchased at VKI (by e-mail: vanhaelen@vki.ac.be or by fax : 32 2 359 96 00). Information can be found on http://www.vki.ac.be.

HOW TO REGISTER

It is highly recommended that the registration/hotel reservation form be sent at the latest 15 days before the beginning of the course. A letter of acceptance and additional information will be sent on receipt of the application form.

ACCOMMODATION & TRANSPORT

Participants are advised to make their reservations as early as possible. VKI secretariat (secretariat@vki.ac.be) can book rooms upon request in the recommended hotels listed below. Daily rates include all charges and continental breakfast. These prices could be subject to changes.

Hôtel des Colonies
http://www.hotel-des-colonies.com Single: 110 € / Double: 130 €

Hôtel Vendôme
http://www.hotel-vendome.be Single: 100 € / Double: 130 €

Thon Hotel Brussels City Centre
http://www.thonhotels.be/ Single: 135 € / Double: 165 €

Hôtel Le Dôme
http://www.hotel-le-dome.be Single: 120 € / Double: 140 €

Hôtel Orts
http://www.hotelorts.com Single: 200 € / Double: 250 €

Progress Hôtel
http://www.progresshotel.be Single: 200 € / Double: 220 €

However, participants could occasionally find special offers on hotel websites.

At youth hostel, the Sleepwell, is within walking distance of the recommended hotels. We invite you to make your own reservation through their website: http://www.sleepwell.be.

The hotels situated in Brussels are all within walking distance from the Gare du Nord and the Place Rogier. A train service links the airport with the Gare du Nord (15' journey). Complete your journey to the hotel/youth hostel on foot or by taxi. Each morning and evening, bus transport will be provided between the Place Rogier and the von Karman Institute, located in Rhode-Saint-Genèse, a suburb south of Brussels.

The following hotel, which is about 1.5 km from the Institute, is also recommended, particularly for those who travel by private car. The hotel is about 12km from the center of Brussels and a high standard of comfort is assured.

Auberge de Waterloo****
e-mail: aubergedewaterloo@skynet.be
Fax : +32 (0)2 358 38 06 - Tel: +32 (0)2 358 35 80
Chaussée de Waterloo 212 -
1640 Rhode-Saint-Genèse

For more information about the location of the Institute and the hotels, please visit our website on http://www.vki.ac.be.

APPLICATION FOR ADMISSION TO VKI LECTURE SERIES

Lecture Series Title: .....

☐ Mr ☐ Mrs
Family name: . . . . . Firstname: . . . . . Nationality: . . . . .
Name & full address of organisation, institution or university: . . . . . .
Phone nr: . . . . . Fax nr: . . . . .
Position or title: . . . . . E-mail: . . . . .
☐ Asking a reduced fee and joining a recommendation letter as: ☐ undergraduate student ☐ Ph.D. candidate or University assistant
Company / University VAT number: . . . . .
VAT of the von Karman Institute: BE 0407 185 709

HOTEL RESERVATION *(if applicable)*

I require accommodation at Hotel . . . . . for . . . . . person(s)
Single: . . . . . Double: . . . . . Date of arrival: . . . . .
I shall require transport to and from the Institute ☐ ☐ Date of departure: . . . . .
I do not require transport to and from the Institute ☐ ☐
Please indicate any special needs (e.g. vegetarian, ..):
. . . . . .

Date: . . . . . Signature: . . . . .

Please mail under-cover to VKI