PHD PROJECT SCIENTIFIC COMPUTING/ILLUMINATION OPTICS

# Hamiltonian optics in phase space

The Department of Mathematics and Computer Science of Eindhoven University of Technology has a vacancy for a PhD-student in its Centre for Analysis, Scientific computing and Applications (CASA). CASA comprises the chairs Scientific Computing (SC) and Applied Analysis (TA). CASA's major research objective is to develop new and to improve existing mathematical (both analytical and numerical) methods for a wide range of applications in science and engineering.

**Background**

In the lighting industry a revolution is taking place. Traditional light sources like incandescent, halogen and gas discharge are being replaced by (light emitting device) LED technology. This new source technology allows the use of more advanced optical solutions. It is the topic of this project to create new methodologies to compute optics that will further enhance the properties of LED lighting. For example, this project will allow the lighting industry to develop new optical designs with less glare, improved efficiency and new light effects.

The optics applied in illumination is nonimaging, in contract to, e.g., a camera lens which is imaging. In nonimaging optics we study the transfer of light from a source to a target. A key problem is to design optical systems such that a given intensity at the source is converted to a desired intensity at the target. The goal of this PhD project is to develop computational methods that can achieve this.

**Project Description**

In nonimaging optics we study light transfer from a source to a target, to control or optimize photometric quantities like illuminous intensity or illuminance at the target. A well-known simulation method for this is the Monte Carlo ray tracing method. In this method, the propagation of randomly selected rays through an optical system, containing e.g. collimators and/or lenses, is computed. The propagation of a ray can be represented in a two- or four-dimensional phase space and can be interpreted as the flow of a Hamiltionian system. Thus, the map which transforms a source distribution to a target distribution is symplectic.

It is the goal of this project to apply this phase space analysis to optical systems in order to:

- Have a better understanding of mixing of light and improve optical systems that mix light. In lighting applications several LEDs are used and in many cases these LEDs have different colors. It is necessary to mix the light of these LEDs to get a good uniform light pattern. Using phase space analysis it is possible to come up with new designs that result in improved mixing properties compared to designs we already know. This approach exploits tools developed in non-linear dynamics.

- Create the optical systems that belong to optical mappings. Using optimal transport theory, we can create optical maps. Based on these optical maps we need to create optical systems that are the physical realisation. Phase space analysis and Hamiltonian descriptions can help us in reaching this goal.

- Create new optical elements with an improved look and feel. Phase space analysis allows us to understand better how light is transported in an optical system. Based on this knowledge we can create new optical elements that have an improved look and feel and are potentially smaller.

This PhD research will be executed in close cooperation with the world leader in lighting: Philips Lighting. The project is embedded in a cluster of projects related to illumination optics and the candidate is expected to work closely with the other PhD students and to be present several days a week at Philips Lighting. This will allow the candidate to have a strong interaction with the engineers that will use the tools after the project has been finished.

**As a PhD student your tasks are the following:**

- Perform scientific research in the described domain;
- Present results at international conferences;
- Publish results in scientific journals;
- Participate in activities of the group and the department;
- Assist SC-staff in teaching undergraduate and graduate courses (at most 20 % of the time).

**Requirements:**
We are looking for talented, enthusiatic PhD candidates who meet the following requirements:

- An MSc in (applied) mathematics, physics or a related discipline with a strong background in computational physics;
- Experience with Matlab and preferably C or C++;
- Creative, pro-active team player with good analytical skills;
- Good communicative skills in English, both written and oral.

**Appointment and salary:**
We offer:

- A full-time appointment for a period of four years, with an intermediate evaluation after nine months;
- A gross salary of €2,062 per month in the first year increasing up to €2,638 per month in the fourth year;
- Support for your personal development and career planning including courses, summer schools, conference visits, etc.;
- A research position in an enthusiastic and internationally renowned research group;
- A broad package of fringe benefits (e.g. excellent technical infrastructure, saving schemes, excellent sport facilities, and child daycare).

**Information**
More information:

- About the project, please contact dr.ir. Jan ten Thije Boonkkamp (TUE), email: j.h.m.tenthijeboonkkamp@tue.nl, tel. +31402474123 or dr.ir. Wilbert IJzerman (Philips), email: wilbert.ijzerman@philips.com, tel. +31610183927.
- About employment conditions, please contact mrs. Corlien van Dam, email: pzwin@tue.nl.

**Application**
The application should consist of the following parts:

- A motivation letter;
- A Curriculum Vitae;
- Copies of diplomas and a list of grades of your studies;
- Names and addresses of two referees;
- Proof of English language skills (if applicable).

**Deadline for application: November 15 2013**