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New *Scattering Information Portal* for the light-scattering community

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Abstract

Current international research needs efficient exchange of information. To constantly keep information for the light-scattering community up to date, a project for a new *Scattering Information Portal* has been proposed. The history and the concept of the project will be described to invite interested scientists to contribute to the project.

1. Introduction

With current international research efficient and fast exchange of information is needed. Advancing software and internet technologies as well as the proliferation of information resources on the web are offering scientist easy access to abundant material of all kind. But there are also many valuable resources often hidden away and hardly available to the community.

However, to gain some benefit for scientific research from these abundant information resources some structuring of the available material is needed, which helps to make available information more accessible. Therefore, different information web sites have been set up by members of the corresponding communities over the years. All these web sites provide relevant information to their communities, but even this relevant information is quite dispersed, quite diverse, and it is commonly difficult to keep all information up to date. One reason for this is of cause that the authors mostly can take care of the web sites only in their spare time.

Within the next years, we will erect a special *Scattering Information Portal* for the light-scattering community.

The next section will give a short overview of the state of general information portals, the area of light-scattering research and existing web information. This is followed by a report on the history of the project. Finally, we shortly outline the concept of the new web portal.

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2. Science information portals

Up-to-date information is essential to the scientific research community. This for example means to offer structured information for specific groups. Over the years information portals have been introduced as web-based access points for different scientific communities to locate scientific documents and a wide variety of scientific information. Web-based information portals are appealing to the scientific community because they aim to simplify online retrieval of information. In this way information can be made available to the virtual community worldwide by internet applications and web technologies.

In Medieval Latin, "portal" means a city gate. A science information portal provides a Web interface to relevant information for scientists [1]. It typically brings together content from diverse widely distributed sources, includes a search tool and links to useful web pages and other information.

The main features of an information portal include [2]

- Organized and structured information.
- Easy to navigate web pages.
- Quick access to relevant news, information, services, applications, and documents.
- A highly interactive interface that provides information.
- Enhanced search capabilities that reduce the amount of time necessary to find sought-after information.

Academic libraries have discovered the power of these technologies as a new method for information distribution [3]. Many university libraries offer web interfaces to their traditional catalogs and additionally some virtual library services like the *Physics Subject Gateway* ViFaPhys [4] and the *Engineering Subject Gateway* ViFaTec [5], both provided by the German National Library of Science and Technology the TIB in Hanover, Germany. Both offer collections of information resources such as link compilations, technical literature, software, organizations, research projects, and conferences.

Alongside this academic library-based information portals many different information portals on specific scientific subjects have been implemented. Of course an exhaustive list would go beyond the scope of this article, so we just would like to give some examples like the worldwide Physics Departments and Documents Network *PhysNet* [6], the *Netlib* Repository containing a collection of mathematical software, papers and databases [7], the "RUSYCON" Portal of Scientific Information for Automation and Remote Control [8] or the Portal for the Ocean Biogeographic Information System [9]. With the HighWire Press, a division of the Stanford University Libraries, there is a list of selected web portals for scientists [10]. This website lists 37 portals that are considered to be of interest to scientists.

3. History, areas, and trends in light-scattering research

In this section, we like to have a brief look at the area we like to cover with the *Scattering Information Portal*. We will shortly review the history of light-scattering research with a focus on developed theories and corresponding computer programs.

As small particles can be found in many different natural, biological, technical, artificial and virtual environments, interest in light scattering covers various scientific disciplines like astrophysics, medical optics, combustion science, color science, or computer graphics. Correspondingly, scattering particles range from interstellar dust, biological cells, soot aggregates, color pigments to computer-generated shape geometries.

Interest in light scattering dates back to Leonardo da Vinci. He was apparently the first to appreciate the role played by the earth atmosphere in the origin of the blue color of the sky [11]. Of course there was also much interest in the rainbow phenomenon [12]. The first explanation for the existence and shape of rainbows was given by René Décartes in 1637 [13].

In 1908 Gustav Mie tried to explain the red color of colloidal gold particles [14,15] and published a first theoretical treatment of the optical properties of spherical particles. His original paper from 1908 is still much cited today [16]. In addition to the subjects mentioned above, these citations within books cover sun screens, radio waves, biophotonics, polymers, dynamics of droplets, road lighting, and food analysis.

A first English version of Mie's theory was published by Bateman in 1915 [17], the first well-documented Mie code in the Fortran programming language was published by Dave as an IBM report in 1968, which was even available in the 1990 [18].

For tens of years arbitrary-shaped particles have been approximated by spheres such that Mie's theory could be applied. Important landmark books for the development of light-scattering theory and methods with a focus on Mie's theory include the books by van de Hulst [19], Kerker [20], Bohren and Huffman [21].

But as more sophisticated theories and faster computers become available, there is a shift to consider the real shape of particles of interest in light-scattering computations. Over the years many different light-scattering theories have been developed. Recent reviews of this field have been published by Wriedt [22] and Kahnert [23]. Mishchenko et al. [24] provide a data base of the literature on one of the more well-known methods, the T-matrix method.

A monograph including Fortran programs based on the T-matrix method for axisymmetric particles was published by Barber and Hill in 1990 [25]. A fast versatile Fortran program based on the multiple multipole method suitable for particles of arbitrary shape became available in 1993 [26].

Particle shapes of interest became more and more complex. The developed programs have been applied to compute scattering by clusters of particles, and an intercomparison between results from different programs is provided by Comberg et al. [27] and Hovenier et al. [28].

Until recently, there was a problem to compute scattering by long finite fibrous particles using advanced theories. Now different fast surface-based methods are available and computational results have been compared [29]. The state of the art to compute scattering by a red blood cell, considering the realistic biconcave shape, is published by Eremina et al. [30]. Additionally, an incident laser beam need no longer be approximated by a plane wave, instead the real intensity distribution of the beam can be considered [31,32].

Another current field of fast progressing research with many interesting applications is particle-on-surface scattering taking into account particle surface scattering interactions. The field of application ranges from particle surface scanners [33], laser cleaning [34], biosensors, near-field optics [35], and total internal reflection microscopy (TIRM) [36]. Originally, many approximate theories have been developed in this field but a recent paper demonstrates that particle surface scattering interaction cannot be neglected and has to be fully included in the scattering theory. Conducting simulation runs using two exact theories (DSM, NFM-DS) to compute TIRM calibration curves demonstrates that complex scattering problems can be simulated nowadays [36]. For a more extensive overview of the current state of light scattering, we would like to refer the interested reader to the Light Scattering Reviews book series edited by Kokhanovsky [37].

4. Available web information

In this section, we shortly like to review the kind of information provided by different existing web sites. Again this can be just examples and not an exhaustive list.

4.1. Discrete dipole approximation

On this new web site [38] the *Discrete Dipole Approximation* (DDA) for scattering calculations, including the relationship between the DDA and other methods, is reviewed. Computational considerations, i.e. the use of complex-conjugate gradient algorithms, Fast-Fourier-Transform methods, or order of scattering approximation are discussed. The method itself was reviewed by Draine and Flatau [39] and more recently by Yurkin and Hoekstra [40]. The authors intend to provide up to date information about extensions and applications of the DDA as well as basic information about the method. Additionally, links to latest papers on the method are given.

4.2. AI SPbU library of scattering codes

The *Astronomical Institute of St. Petersburg University (AI SPbU) library of scattering codes* [41] presents Fortran code to calculate the optical properties (efficiencies, albedo, asymmetry factor) of spheres, infinite circular cylinders and spheroids. The web site includes a list of links to other available programs in the internet

[42]. It also includes *Reference & Data Base of Optical Constants* [43] and additionally a list of reviews and books on this subject.

4.3. Electromagnetic Scattering Programs

Both the list of *Electromagnetic Scattering Programs* by Wriedt [44] and *SCATTERLIB Light Scattering Codes Library* by Flatau [45] have been founded at about the same time at the beginning of the 1990. They mainly focus on providing information about computer programs. The listed programs are grouped into different sections. There is an extensive list of Mie-type codes including Mie and stratified sphere programs in almost all program languages from Fortran and Pascal to Matlab and Maple. The other groups are particle on surface, multiple particles, T-Matrix codes, point matching codes, generalized multipole technique, methods of moments codes, volumen integral codes, time domain codes, and finite elements codes. Additionally, information about new books or upcoming conferences is given.

4.4. Topics in Particle and Dispersion Science

Topics in Particle and Dispersion Science [46] is an online publication intended to provide a concise review of interdisciplinary topics of particle dispersion science, with an emphasis on the most recent developments, especially in light scattering. It is extensively cross-referenced and can be accessed via several convenient threads. There is a literature survey of the recent publications on particles and dispersions in representative journals. These publications are referred to by the index and are intended to be discussed by the topical notes. There are a number of topical notes and problems for classroom use and this can be accessed by a table of contents. The web site includes an alphabetically ordered hierarchical list of keywords linked to specific topical notes and references and an extensive list of relevant publications, mostly linked to internet-based document sources and numerous, periodically tested links to the authors' webpages and internet-based contact sites. This thread combines the references thread with the discontinued authors thread to simplify viewing and maintenance.

Finally, there is a dictionary of definitions, abbreviations, and acronyms used in this publication.

5. Other existing information web sites

As we cannot go into detail with every existing information source in respect of light scattering, we would like to go on with a short overview over other existing information web sites that are intended for the light-scattering community or which may be of interest for all researchers working in this field. For the light-scattering community there is the *Directory of Members of the Electromagnetic Scattering Community* by Mishchenko [47] listing members of the community with their addresses and email data. The *Electromagnetic and Light Scattering by Particles Newsletter* is published regularly by Kolokolova [48]. Additionally, there is the *Minsk bibliography on light scattering* [49], the *Database of Optical Constants* [43] and the *Amsterdam Light Scattering Database* [50]. Gustafson provides a *Database of microwave-analog-to-light-scattering data* [51].

Finally on the finite difference time domain method (FDTD), there is an extensive list of published literature in the *BibTeX FDTD database* by Schneider [52].

6. History of the project

The new project dates back to the internet side *Electromagnetic Scattering Programs* [44] that exists nearly for 14 years. It was started following the first "Seminar Mie theory" organized at Technische Universität Clausthal, Clausthal-Zellerfeld, Germany, on July 8, 1993. This seminar was intended to clarify some problems, which at that time seemed to exist with some computer programs based on Mie theory. To have a close look at these problems there was a comparison of computational results from different programs at this workshop. It soon became clear that problems could easily be solved by using the latest program published at that time by Wiscombe on an FTP server [53]. A first overview of the available scattering programs was presented at the seminar and published later [54]. Following the seminar, a first *List of available*

electromagnetic scattering programs [55] was published on the web server of the Faculty of Production Engineering of the University of Bremen. With the help of the Internet archive www.archive.org the development of this web page can be traced back to December 3, 1998 [56].

7. Concept of the new information portal

In this section, we like to shortly explain the concept of the new *Scattering Information Portal* web site we plan to erect within the next year. The basic features of the information network will include the following topics, which we think are of utmost convenience to the community.

- Up to date information related to the subject of light scattering, e.g. conference announcements, free jobs, new books, retirements, or address changes.
- List of scientists and research groups working in the field of light scattering including subjects of research.
- Database of available computer programs.
- A user forum for researchers and students in the field.
- Database of validated computational results.
- Alerting service by email.
- Frequently asked questions.

One topic of high priority is the list of available computer programs. We intend to start the project by updating information from our previous web site *Electromagnetic Scattering Programs* [43].

The focus is to track down dead or broken links and then to recover lost programs by contacting the authors either to ask for an update or to ask for the permission to offer a copy via the new portal. So the programs would be available directly, by link or as a scan of a printed version. For the latter, we might consider a transfer to electronic format using optical character recognition.

Also, the other offers of the information portal will consist of directly hosted information on the one hand and web links to material of interest provided by community members on the other hand. The idea is not to replace existing offers but to collect and sort them to make them easier to find for interested users. This particularly includes the offer of support to third-party community members if needed and wanted. This will be explained in more detail in the next paragraph.

We hope that the erection of the information network will lead to discussion with interested scientists, which will help to improve on the current concept.

8. Collaboration

Collaboration among teams and different research groups is among the most critical point in current international research. To assist collaboration we will include a system for team-based activities such as shared projects, discussions, calendars, and ideas.

Also such a *Scattering Information Portal* web site cannot be erected without assistance from the scientific community and international collaboration. We therefore would like to invite all scientists working in the field and interested in the project to contribute to the concept first of all. This can be done by sending us your opinions, recommendations, and wishes, or even more actively by participating. Technically, the implementation of a content management system is planned to give access to the content of the service to interested colleagues. In the later stage of the project, we would need editors who like to care for a special topic included in the *Scattering Information Network* e.g. new programs or new books published. Any kind of input is welcome.

9. Conclusion

Scientists of all fields have to cope with the increasing importance of information exchange of a growing community.

By simplifying information access and by providing an organized view on the subject of light scattering within this new Scattering Information Portal, we intend to benefit the scattering community and especially to contribute to international collaboration within the light-scattering community working in different scientific disciplines. We invite every interested member of the community to contribute to this project.

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