Infrared

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PREFACE

Infrared

'Infrared' is a very wide field in physics and the natural sciences which has evolved enormously in recent decades. It all started in 1800 with Friedrich Wilhelm Herschel's discovery of infrared (IR) radiation within the spectrum of the Sun. Thereafter a few important milestones towards widespread use of IR were the quantitative description of the laws of blackbody radiation by Max Planck in 1900; the application of quantum mechanics to understand the rotational–vibrational spectra of molecules starting in the first half of the 20th century; and the revolution in source and detector technologies due to micro-technological breakthroughs towards the end of the 20th century. This has led to much high-quality and sophisticated equipment in terms of detectors, sources and instruments in the IR spectral range, with a multitude of different applications in science and technology.

This special issue tries to focus on a few aspects of the astonishing variety of different disciplines, techniques and applications concerning the general topic of infrared radiation. Part of the content is based upon an interdisciplinary international conference on the topic held in 2012 in Bad Honnef, Germany. It is hoped that the information provided here may be useful for teaching the general topic of electromagnetic radiation in the IR spectral range in advanced university courses for postgraduate students.

In the most general terms, the infrared spectral range is defined to extend from wavelengths of 780 nm (upper range of the VIS spectral range) up to wavelengths of 1 mm (lower end of the microwave range). Various definitions of near, middle and far infrared or thermal infrared, and lately terahertz frequencies, are used, which all fall in this range. These special definitions often depend on the scientific field of research. Unfortunately, many of these fields seem to have developed independently from neighbouring disciplines, although they deal with very similar topics in respect of the underlying physics. There are now at least six different disciplines that deal with infrared radiation in one form or another, and in one or several different spectral portions of the whole IR range. These are spectroscopy, astronomy, thermal imaging, detector and source development and metrology, as well the field of optical data transmission. Scientists working in these fields range from chemists and astronomers through to physicists and even photographers.

This issue presents examples from some of these fields. All the papers—though some of them deal with fundamental or applied research—include interesting elements that make them directly applicable to university-level teaching at the graduate or postgraduate level. Source (e.g. quantum cascade lasers) and detector development (e.g. multispectral sensors), as well as metrology issues and optical data transmission, are omitted since they belong to fundamental research journals. Using a more-or-less arbitrary order according to wavelength range, the issue starts with a paper on the physics of near-infrared photography using consumer product cameras in the spectral range from 800 nm to 1.1 μm [1]. It is followed by a series of three papers dealing with IR imaging in spectral ranges from 3 to 14 μm [2–4]. One of them deals with laboratory courses that may help to characterize the IR camera response [2], the second discusses potential applications for nondestructive testing techniques [3] and the third gives an example of how IR thermal imaging may be used to understand cloud cover of the Earth [4], which is the prerequisite for successful climate modelling. The next two papers cover the vast field of IR spectroscopy [5, 6]. The first of these deals with Fourier transform

infrared spectroscopy in the spectral range from 2.5 to 25 μm, studying e.g. ro-vibrational excitations in gases or optical phonon interactions within solids [5]. The second deals mostly with the spectroscopy of liquids such as biofuels and special techniques such as attenuated total reflectance [6]. The two final papers deal with what seem to be wholly different scientific fields [7, 8]. One paper describes SOFIA, an aeroplane-based astronomical observatory covering the whole IR range [7], while the other represents a small review of the quite new topic of terahertz physics at the upper end of the IR spectral range, from around 30 μm to 3 mm wavelength, and its many applications in science and industry [8].

Although artificially separated, all these fields use similar kinds of detectors, similar kinds of IR sources and similar technologies, while the instruments use the same physical principles. We are convinced that the field of infrared physics will develop over the next decade in the same dynamic way as during the last, and this special issue may serve as starting point for regular submissions on the topic. At any rate, it shines a light on this fascinating and many-faceted subject, which started more than 200 years ago.

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