WG4 COST Action MP1302

Report on Nanospectroscopy Textbook

Planning and Structure

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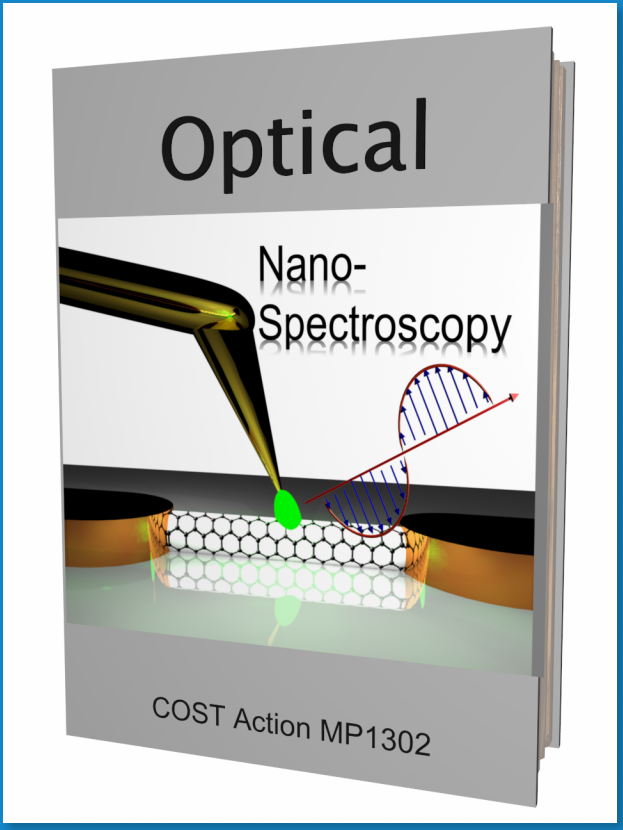

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Overview

Introductory Comments

The COST MP1302 Action Textbook should have the ambition to be a landmark publication drawing on the complementary expertise of the MP1302 Action membership. Few textbooks would have previously been projected from such an enormous array of expert and skilled people. Our textbook should not just be another in a forest of textbooks, but a tree so tall it is a clear landmark. It should have immediate relevance throughout Horizon 2020 and indeed be seen by future historians of science subsequently as being the important landmark in the emergence of new findings in nanoscience and nanotechnology.

Given this ambition to produce this landmark MP1302 textbook, it is obvious that this will not materialize from contributors writing on topics in an uncoordinated and unstructured way. The planning of this project needs deep thought and must be based initially on library research so that those planning the textbook have a comprehensive overview of all relevant information. This review delivers comprehensive details of earlier work; relevant publications; numerical analysis; structural analysis of the topic and so on. This project grounding here as far as possible is based on objective information that is useful in planning the structure of our coherent textbook. It is universally acknowledged that achieving with several authors a coherent textbook presents a significant logistical challenge.

The starting position is to critically examine the existing publications on nanospectroscopy, which includes both books and review articles. Nanospectroscopy is in fact made up from a number of sub-topics; the importance of each possible constituent topic, its growth, and its relationship with other sub-topics is here vital to understand. It has been appreciated that a proper pedagogical structure to the volume is required in order to assemble these component chapters into a coherent whole. A starting point is to critically evaluate previous important work that must obviously be identified; this includes a survey of relevant review articles on all subdivisions of the topic. Copies of these papers clearly must be available to the editorial team. The theory to underpin the educational template and structure of the book needs to be properly researched and the editors must agree on this as this is of central importance for coherence. The authors of this report maintain there is absolutely no possibility of a coherent approach emerging without all this vital groundwork being done.

The Impact Factors Key to Designing the Textbook

The book needs to be seen by potential readers unfortunately with superficial inspection as being highly relevant and hot topics, industrial applications and other key features need to be

delineated and connected organically into the structure. Such superficial issues are more than mere marketing, as these in large part will determine the success of this textbook. There is clearly considerable preparatory work needed in planning the project before contributions are properly specified and prospective authors are approached to take on writing the chapters.

This report presents in a succinct way the principles of developing this project to move forward and establish our practical approach to developing the publication. From here there is a need to quickly flesh out a concrete proposal for a coherent content and structure. The educational principles that will underpin successful tutorial textbooks at this stage needs to be decided by the editorial team and then implemented in determining this coherent content. Despite some serious effort at this point, disappointingly, no obvious candidate for this pedagogical approach and principles has yet been identified. Some professional assistance has been sought from professional librarians to address this shortcoming.

Sharpening our Thoughts and Vital Strategic Decisions

Clarification of exactly what is meant by this word ‘Coherent’ in the context of our textbook. An understanding of the precise meaning of this word is arguably vital to developing a satisfactory content of the textbook. The authors believe that what is being sought is indeed an ‘apposite chapter structure’. Given the meaning of the word apposite taken from the Oxford Dictionary of the “application of placing side by side, placing a word in a syntactic parallelism with another” it can be argued that what we are seeking ‘an apposite and coherent chapter structure’. Content must develop in a related and hierarchical way to provide a superstructure allowing for the embedding of an optimally, or at least well-designed, pedagogical tutorial structure. The authors suggest this nuance in meaning of the MP1302 ‘coherent’ word is important in defining the objective of the library resarch described here.

The appointment of an Editor-in-Chief is recommended and from there the editorial team needs to obtain commitments from lead authors of the various chapters and/or tutorial sections to take on the work. A little thought is given to this vital task with recommendation as to a proper approach needed here. The submission then of proposals to various publishers would be needed and involves producing timelines on the production of the volume. The authors of the report tentatively propose the textbook publication by early 2016. This would give a reasonable time frame to structure and achieve the several tasks involved with the textbook production.

The report concludes with a recommendation that this initial general nanospectroscopy volume will be developed as a COST MP1302 series. The suggestion of a developing nanospectroscopy application series leading from this initial ‘fundamentals of nanospectroscopy’ volume seems a suggestion that would make the project not more difficult but on the contrary more tractable. Contributors will deliver tight chapters given they understand there is a

developing series of material they ‘do not have to squeeze in’. The second applications volume should be on Single Molecule Spectroscopy that could hopefully also be a deliverable from WG4 published before the end of our COST MP1302 Action.

Scoping of WG4 Project

Beyond Scoping Meta-Review

The plan would be draw on ideas developed by Sarrami-Foroushani et al. 1. This approach is based on a ‘Scoping Meta-Review (SMR) which is described as including: “undertaking a preliminary nonsystematic review; building a search strategy; interrogating academic literature databases; classifying and excluding studies based on titles and abstracts; saving the refined database of references; revising the search strategy; selecting and reviewing the full text papers; and thematically analyzing the selected texts and writing the report.” This approach being the only directly relevant reference has been adopted in this report. It is worth noticing that the first draft of this report was written before the work of Sarrami-Foroushani appeared on our radar. In essence it was from empirical research that a similar methodology was identified but this work should help the editorial team to be more confident in the systematic approach being adopted. This vital publication will be obtained and sent to all the editorial team,

Another report by the US Library is also of importance here Colquhoun et al. 2 but this is more concerned with strictly defining the terminology used in scoping reviews and studies.

The objective of this report is writing a scoping study to enable an adequately planned submission to be sent to publishers.

Starting with the Obvious - Defining a Textbook

Defining the Textbook

A textbook is an organized body of material useful for the formal study of a subject area. A good textbook is distinguished by:

- A discrete, well-bounded scope: all the material should relate to a solid understanding of the subject, usually mixing theory and practice for each topic as it covers the subject domain.
- Use of examples and problems: the student should be able to better grasp each presented concept by following examples, and then applying the concept in structured exercises or problems.
- An internally consistent style: after the first few sections, there should be little or no surprises for the student in terms of layout and presentation of material. The text user can get comfortable with the layout, the tempo of presentation, and the pattern of figures, illustrations, examples and exercises. Excellent information display is required (use of figures, tables, graphs, headers, bolding, and color) towards optimizing the learning processes.
- Utility for future reference: once reviewed, the textbook should single out the essential material useful to the future application of subject knowledge. This can be accomplished in the form of well-organized appendices and tables.

A structure that makes sense: the textbook is not just a collection of useful material, it is a guide to the student for an order of review which will aid in mastering the subject area and help move forward if the student get stuck trying to understand a particular concept. Topics are presented in major parts, chapters, sections and subsections that are organized in a way that facilitates understanding. This means that the text's organization is based on the intersection of two requirements. The first of these are the requirements of the subject domain. Since most textbooks are developed by, or based on the contributions of subject matter experts, this requirement is usually well attended to.

The second requirement is defined by the limits of the reader’s mind. Cognition is a common human ability, but its needs and limits are frequently ignored by those who have already mastered a subject area. To make the best use of the student's abilities, some rules can be spelled out for the structuring and presentation of ideas, concepts, and material.

In short, the editorial team needs to furnish the contributors with some very strict guidelines and furthermore to ensure their directives are fulfilled in all the chapters.

The Clarification of ‘Coherence’

Our special requirement for the COST MP1302 textbook needs intellectually to be clarified. The ambition to deliver a ‘coherent’ textbook means that the editorial team cannot shirk a responsibility to define the overall structure of the textbook and to this effect require the authors of the individual chapters to observe a uniform consistent approach to the presentation of their

topic. The contributors cannot be carried away doing ‘their own thing’ and disregarding the educational requirements of the textbook. The important elements of thought here are defining the objectives, concepts and clarifying the issues; the knowledge of facts; clarity on defining the theories, axioms, principles, models; appreciating the implication of assumptions; defining our point of view, frame of reference, perspective and orientation. A very effective presentation of these matters is given by the Foundation for Critical Thinking 3.

"Critical thinking is the intellectually disciplined process of actively and skilfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness..." 4. The authors believe to achieve a cutting edge delivery from contributors will be helped by the editorial team from the outset using a simple Mnemonic to keep at the front of the minds of the contributors what is required to deliver coherence. The approach recommended would be the ‘3Cs approach’. Our textbook must have contributions that both connect with adjacent chapters and an internal consistency.

What are the 3Cs? Firstly, each chapter must in itself be a complete and rounded presentation. The ‘completeness’ of chapters cannot be simply assumed. Guidance notes need to be provided by the editorial team to the contributors. The second factor is ‘comprehensiveness’ defined here initially from the library research into individual topics. This research however is defining only a first pass at this comprehensiveness. Comprehensiveness comes securely from the expertise of the contributor who must be professionally at the top of their game and using the guidance of our structure and using their unrivalled expertise to deliver comprehensiveness. The first two Cs are really assumed generally in planning textbooks but are unfortunately never a given. The final C is of course Coherence, which will only be achieved as the outcome of completeness and comprehensiveness. An interlocking structure of the final volume in chapter-to-chapter structure of the textbook must be based on a hierarchical approach building from low to high level topics to ensure ‘a learner’ can ascend properly through both a topic but crucially stepwise through the science of nanospectroscopy.

Rules of Presentation

The rules of presentation included for writing a textbook are key and although there is little point here in trying to reinvent an old wheel, there is however some insights that might be useful to the reader. In order to flag the reader to this important issue Appendix 1 has presented some information that in itself is not tailored to the needs of our COST MP1302 textbook. It is presented in an appendix to highlight the need for such clarity of thought on our own project and

such rules of engagement should never be written without the plan of battle being laid out fully. It is sufficient here therefore to provide the example of such rules in an appendix for the edification of the reader if they so choose.

Existing Textbooks

Lessons to be Learned

- The Appendix File 1 Existing Textbook on Nanospectroscopy and related topics is something that should be looked at carefully. The approach recommended is to critically analyse these and learn vital lessons for our MP1302 Textbook project by trying to overcome any limitations that can be understood from these early efforts to address the need of our research community for such a book. The authors strongly think that it is of little value simply just taking a lead from these publications and doing essentially the cloning with some updating of content.

- The authors offer in bullet points here some initial critical evaluation of these books but these are not meant in any way to be definitive. Comments in bullet points of publications below on details included in Word document 'NANOSPECTROSCOPY Textbooks.doc' in Appendix 1.

- The key instrumentation and optics challenges of moving beyond the diffraction limit of light and the optics and photonics issues related to nanospectroscopy are dealt with by Ohtsu 5. This work is not concerned with the great sweep of applications in nanospectroscopy. The book however gives a comprehensive survey of nano-optics and nanophotonics which claims to be the only existing handbook about optical near-field techniques giving tutorial step-by-step descriptions of the principles and practices of nano-optics

- Uddin has edited another (open access) textbook 6 on this issue of moving from macro to nano spectroscopy. The content of this book is quite removed from nanospectroscopy and perhaps should be more properly titled approaching nanospectroscopy from existing macro applications.

- Fukima et al. 7 in Molecular Nano Dynamics, Vol. I and Vol. II explores more than 40 important methods for dynamic observation of the nanoscale in a book that is surprisingly still relevant despite its publication date. Edited by absolute science greats from Japan, this two-volume set covers all important aspects of this topic: nanoscale spectroscopy and characterization tools, nanostructure dynamics, single living cell dynamics, active surfaces, and single crystals. This book underlines the importance of obtaining the highest quality of contributors for the COST MP1302 textbook as the advertising material for this 2009 book

states “Edited by absolute science greats from Japan, this two-volume set covers all important aspects of this topic: nanoscale spectroscopy and characterization tools, nanostructure dynamics, single living cell dynamics, active surfaces, and single crystals.”

- Molecular Nano Dynamics, Volume I: Spectroscopic Methods and Nanostructures Edited by H. Fukumura, M. Irie, Y. Iwasawa, H. Masuhara, and K. Uosaki C (2009 WILEY-VCH) is included in Appendix 2. This has the full contents and substantial extract of the volume.

- There are existing textbooks on important topics in nanospectroscopy for example the eTextbook on ‘Nanoplasmonic spectroscopic imaging’ by Choi 8. There are a number of proceedings on nanospectroscopy such as the recent 2013 SPIE Proceedings publication edited by Verma 9. There is really no attempt in such books to deliver a coherent textbook but they give a snapshot of the state-of-the-art in a field and this one is representative of such a publication. This is an opportunity and a gap in the literature that our textbook should fill.

- There is a series of textbooks being developed under the editorship of Richard Palmer who is a leader of WG1 of the COST MP1302 Action. At this time five volumes have been published10_ENREF_11_ENREF_12_ENREF_13_ENREF_14. The series began appropriately given Richard’s own expertise on Nanostructured Materials. The series then stepped Atomic and Molecular Manipulation: Metal Nanoparticles and Nanoalloys; Naonobiotechnology; and Nanomedicine. These books are concentrating on the tractable well defined nanotopic and should be a salutary lesson to the WG4 ambitions to produce a coherent textbook.

- There are two other books that are references: Near-Field Optics and Surface Plasmon Polaritons, Kawata 2001 11 and Principles of Nano-Optics, Novotny, 2006 12. This latter book from Lukas Novotny is an excellent example (cited over 2000 times!). Since its publication 8 years ago now we have a good chance to build from such a work.

- Last and certainly not least we see the most recent and impressive of all publications from a group of editors including K. Kneipp. This publication with 330 pages clearly highlights a problem for our proposed textbook which clearly underlines the fact our own publication cannot possibly cover in such detail the range of topics comprising nanospectroscopy as seen in this book. Frontiers of Surface-Enhanced Raman Scattering: Single Nanoparticles and Single Cells13 comprehensive presentation of SERS provides detailed presentation of an centrally important area for the textbook covering theory, substrate fabrication, applications of SERS to biosystems, chemical analysis, sensing and fundamental innovation through experimentation. SERS applications are widely expanding and the technology is now used in the field of nanotechnologies, applications to biosystems, nonosensors, nanoimaging and nanoscience. A fundamental question arises here as to if the sweep of the topic can indeed be dealt with in a single textbook. Katrin’s Poster for her course on Nanospectroscopy in DTU-Fysik which is a useful visual is included in the General Appendix File.

Readership

The aim of WG 4 is to have book on Nanospectroscopy which has a dual purpose in it could be used for both teaching purpose at undergraduate level, but beyond that will in particular light the path for young researchers in nanospectroscopy and adjacent fields. The book should also be a source of inspiration for all researchers in the field and will aim to become the standard reference for undergraduate teaching programmes and those writing papers on topics in the field; it should be the first port of call hopefully after a researcher reads the Encyclopedia article on a topic. It should be educational, powerful, clearly written, diagrams beautifully presentation, and above all easily understandable that hopefully graduate students will refer to it as The Bible of the field. The textbook therefore should give a broader and more authorative exposition of topics than can be obtained from any review article because of the 3Cs but most specifically the unique planned and editorially engineered ‘coherence’ of this textbook. The first rule of intelligent composition is to know who the readership is for the proposed work, so this short section is of paramount importance to the project.

Shouldn’t we include a section on “Internet Resources”? The authors suggest probably with animations and videos of experiments ran by the co-authors, simulations, supplementary information, etc.

Science Direct and Web of Science Analysis of Articles on Nanospectroscopy

Science Direct Analysis

There are some thirty plus full text Science Direct review articles 2009-2014 (see Appendix 2 File) that are found from a ‚nanospectroscopy’ search but nothing specifically titled just ‘Nanospectroscopy’. The graph of the publication numbers is shown in Figure 1 with earliest publication on nanospectroscopy appearing in 2008 and peaking in 2012; paradoxically, the

numbers have decline since 2012. The Science Direct numbers indicated a figure of 55 in total from 2009 to 2014 for just a nanospectroscopy search. Reason for this anomalous decline is probably reclassification of a topic in the search engines in the growth area of nanospectroscopy.

In this file on the USB key is also a WORD document detailing the Web of Science general articles that are found from the 'nanospectroscopy' search 1994-2014. A file with the five most important nanospectroscopy publications are included in Appendix 3. The structure of this topic perhaps is indicated here with articles flagged as being nanospectroscopy on Raman, near-field, biosensors, plasmonics, single molecule spectroscopy, biotechnology, nanomaterials and more.

Web of Science Analysis

The deeper analysis of this analysis is presented in a table.

Year	Chemistry	Physics/ biophysics	Pharmaceutical	Total/No of categories
2004	189	158	3	621(12)
2009	1000	550	7	1650 (19)
2010	1050	1050		
2011	1800	1100		
2012	1900	1150		
2013	1950	1200	8	16505 (19)
2014	900	550		

Table 1: Sample of nanospectroscopy articles in 'Web of Science'

The growth of nanospectroscopy conundrum with quite significant 'orders of magnitude' differences appear over the last decade with respect to Science Direct and the Web of Science search is explained because we are looking at review articles and general articles. The Web of Science numbers grow most strongly in period 2004 to 2009 with a 529% but since in next 5 year period reducing to something about 200%. This slow down mirrors the decline in the Science Direct publications. The growth of subdivisions of the subject according to Web of Science categories grew from 12 to 19 in the initial period up to 2009 and remained the same after that. The categories in 2013 which is the last full year we can analyse are chemistry (189), material science (301), physics (272), electrochemistry (18), biochemistry/molecular biology

(18), biophysics (16), engineering (10), pharmaceutical (8), Biotechnology/Applied microbiology (8), polymer science (7), instruments/instrumentation (5), Food (5), Mathematical Computational biology (3), Computer science (3), Environmental (2), Toxicology (1), Thermodynamics (1), Nutrition (1), Nuclear (1), Dermatology (1). Some topics like Oceanography, NMR radiology and mathematics came up for 2004 search but had disappeared in 2013.

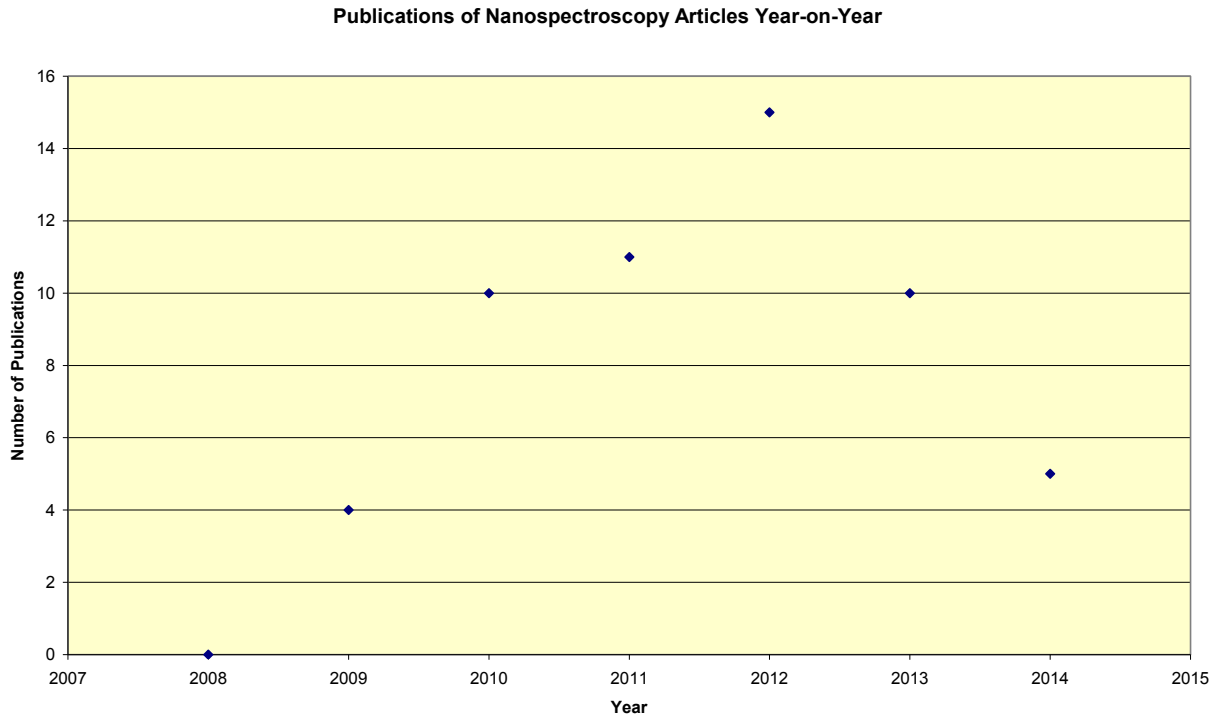

Figure 1. Growth of nanospectroscopy publications year-on-year in refereed literature.

The conclusion here is that nanospectroscopy has been dominated by categories chemistry and physics in entire decade. Few categories have changed significantly and this analysis really suggests that there has been a fairly uniform growth in all categories in the last decade and no major shifts in the structure of what could be recognised as nanospectroscopy. Importantly, the major conclusion here is that the structure of the field nanospectroscopy seems to have acquired a stable form.

General Web of Science Research

Single Molecule Spectroscopy Analysis

The Web of Science study was then extended but in a more analytical way using double categories, for example ‘Nanospectroscopy’ and ‘Single molecule spectroscopy’ (SMS) which for 2009-2014 period had 9781 papers but with a finer subject subdivision of 69 topic divisions. The number of publications in each category stretched from Chemistry with 5889 down to Automatic Control with just 1 article. These categories for articles include Biophysics 523, Cell Biology 121, Virology 9, Geology 3, and Ecological Biology 1 and 64 others. This double category search gives a very good view of the topics and these should be targeted to give a broad view of a subject by then seeking review articles that allegedly are written by an acknowledged expert in the field. The abstracts of review articles that are available from Web of Science are saved in a series of WORD files 2009 to 2014. See Appendix 4. In this File are pdf publications that are available for each year. The breakdown into subsets gives the following counts for review articles Chemistry (292); Physics (121); Environmental (33); Microbiology (20); Instrumentation (20); and Optics (8).

The breakdown into categories for papers on single molecule spectroscopy with 9781 papers published in this category 2009-2014. The breakdown here is chemistry (5886); Material science (2025); Physics (2869); Science technology (1745); Biochemistry/ Molecular Biology ((827); Biophysics (523); Crystallography (327); Optics (374); Spectroscopy ((328); Polymer science (198); Engineering (167); Instruments/ instrumentation (135); Cell Biology ((121); Electrochemistry (119); Pharmacology/Pharmacy (117); Biotechnology/Microbiology (72); Environmental/Ecology (33); Energy/Fuel (33); Radiology/Nuclear Medical Imaging (32); Life Science/Biomedical (32); Microscopy (31); Computer Science (26); Food Science (25); Mathematics (20); Mathematical Computational Biology (19); Research Medical (18); Immunology (11); Virology (9); Toxicology (9); Oncology (9); Genetics/Heredity (8); Agriculture (8); Nutritional/Dietics (7); Mechanics (7); Thermodynamics (6); Anatomy/Morphology (6); Physiology (4)’ Developmental Biology (4) Dermatology (4); Geology (3); Endocrinology/ Metabolism (3); Cardiovascular Systems/Cardiology (3); Telecommunications (2);Psychiatry (2)’ Pathology (2); Infectious Diseases (2); Forestry (2); Allergy (2); plus 18 other categories with a single publication.

Some numerical information on the growth of SMS is useful. Figure 1 shows year-on-year publications of general papers on SMS which shows a fairly steady growth from 1990 until 2012 and a significant step up in rate of more than a doubling of rate.

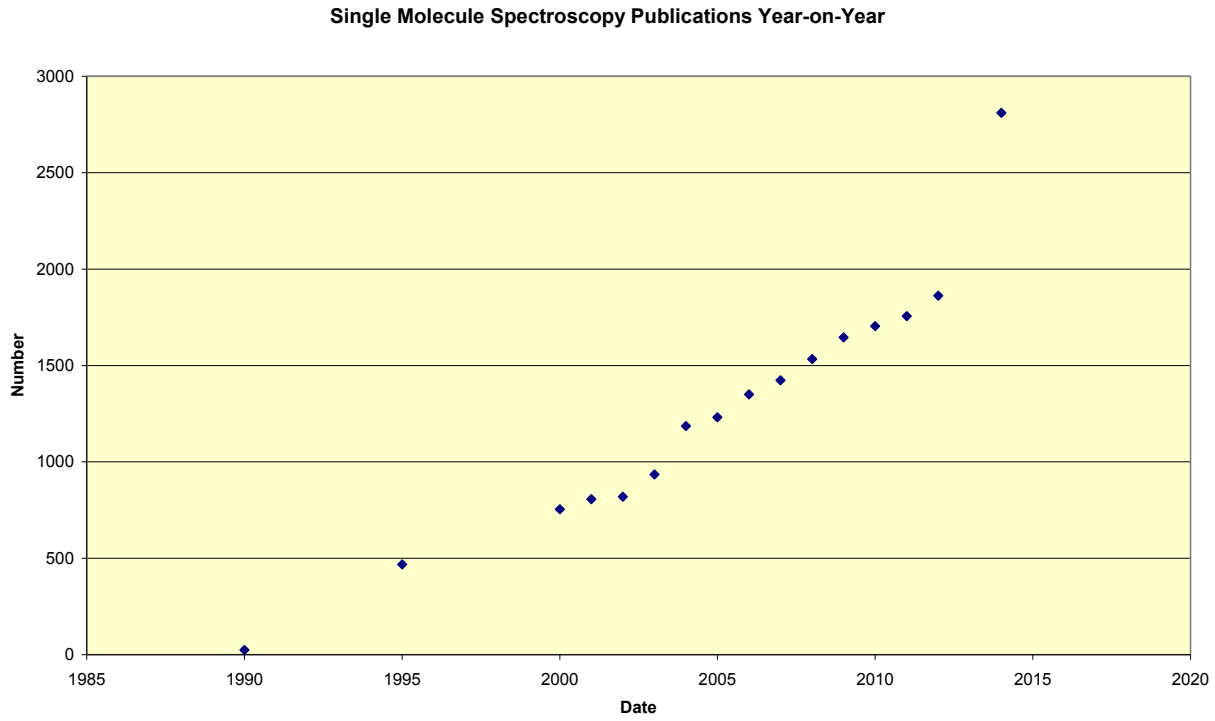

Figure 2: Year-on-year numbers of publications in single molecule spectroscopy

Article Survey of SMS Publications

The initial work in planning the textbook needs to come from identifying review articles for all the large component topic fields of nanospectroscopy. Taking as the example the largest field 'Single Molecule Spectroscopy' (SMS) it is clear there exist constituent component areas within this larger field. SMS is the biggest and most dynamic component in nanospectroscopy field. The time spent looking at review articles and categories that appear for this topic in Web of Science has provided a very thorough overview of SMS and indeed deepened considerably the insight into nanospectroscopy itself that was not delivered by the earlier search. I feel there has emerged a larger overview that hopefully will be useful in planning the textbook. This example of the work on SMS has in fact been undertaken on all component fields of nanospectroscopy. Collectively, the work allows these differentiations within the subject fields so the component parts of the fields that will enable the best-fit assemblage of the topics and help build across the whole textbook. The investigation of the component parts of the fields has been conducted with a view to the best-fit arrangements in the overall structure of the book.

Science Direct and Web of Science of SMS

The Appendix 5 contains the Science Direct review articles in files 2010 (5 articles); 2011 (4 articles); 2012 (6 articles); 2013 (24 articles) to 2014 (9 articles) which are on a whole sweep of topics from SMS in cells, to ribosome-catalyzed protein synthesis, gene expression, frontiers of two-dimensional correlation spectroscopy and molecular biodiversity to take a random selection of just one paper from each of the files. The Web of Science analysis from 2009-2014 is divided into the key category subsets Chemistry (292 entries) ; Physics (121 entries); Optics (8 articles); Instrumentation (20 entries); Environmental (33 entries); and Microbiological (20 entries).

Analysis of Other Component Subjects in Nanospectroscopy

The Science Direct component subjects of nanospectroscopy 2009-2014 are included in Appendix File 6 including all the fields suggested by Professor Kneipp. These divisions of nanospectroscopy hereafter are to be referred to as the Kneipp Topics and here in alphabetic order (i) Applications (ii) Biomedical (iii) Far-field (iv) Fluorescence (v) FTIR (vi) IR (vii) Material Science (viii) Nanostructures and Nanomaterials (ix) Process Monitoring (x) STED and STORM. Missing topics: (xi) Surface plasmon and plasmonics

The number of papers discovered in this search are for (i) Applications 8 subdivisions namely Assays (5); Imaging (3); Instrumentation (7); Materials (3); Probing (7); Self-assembly (1); and Sensing (6). One review paper on stencil lithography was hard to classify and unassigned going in the 'Odds and Sods' classification. In some cases the same paper is reclassified in a second search obviously because the divisions here are very unclear. Some 14 review papers were considered here to be of use in giving overviews of the area and in the file 'Good Reviews'. The breakdown then for the other Kneipp topics which are subjective divisions based on reading title/abstracts (ii) to (x) are respectively:-

(ii) Biomedical: Application (2); Imaging (1); and Instrumentation (2) There were 4 good reviews important perhaps from the search that would help with an overview of this subdivision.

(iii) Far-field: Applications (1); Built Environment (1); Imaging (1); Instrumentation (7) ; Materials (3); Medical (3); Research Policy (1); Surface Science (1); Theory (2) and finally Odds and Sods (2). There are seven good review articles identified.

(iv) Fluorescence: Applications (6); Biosensensors (3); Instrumentation (23); Membranes and Interfaces (14); MEMS (1); Theory (3); Medical and Pharmaceutical (3); with 23 good review articles identified.

(v) FTIR just 3 articles with no rational division of these search finds.

(vi) IR with 7 articles of which 4 are good review articles.

(vii) Material Science with 7 articles.

(viii) Nanostructures and Nanomaterials with Nanomaterials (3); Nanostructures (3); Nanoantenna (0). There was a number of 7 good reviews.

(ix) Optical Tweezers 28 (x) Process Monitoring with 5 articles and 3 good review articles.

(xi) STED and STORM with 4 articles.

The identification and classification is done despite an article being really in some cases not being of direct relevance according to the authors. The point here is this work is a useful survey and it would be an initial guide to anyone writing a chapter who could decide whether this was relevant or not.

The SMS analysis was done above as this is the biggest subfield and was used to illustrate the methodology here.

World of Science analysis of the Kneipp topics was done and given the greater depth of search this offers we have a result for the full set of her categories. Again using the same approach here in alphabetic order (i) Applications 1. Optical Spectroscopy for Probing 7. 2. Material Science 2. Optical Spectroscopy for Sensing 3. (ii) Biomedical 1. (iii) Enhanced Local Fields 5. (iv) Fluorescence 8 (v) IR adsorption 5. (vi) Nanomaterials 7. (vii) Nanostructures 13. (vii) Plasmons 5. (viii) Preparation 3. (ix) Probing Local Fields 6. (x) Properties 14. (xi) Raman 18 (xii) Single Molecule Spectroscopy 8. (xiii) STED and STORM 28. (xiv) Surface Plasmons 8.

We can conclude from this study that there is a fairly uniform distribution of importance in the subfields and surprisingly SMS has not shown the proportionately greatest number of papers in its subfield.

Nanodrop Spectroscopy

There were 2 review articles for liquid nanodrop papers in the LDA file of Appendix Subfield File 7 called up in the Kneipp search from World of Science. This nanoscience area is one that today provides the largest market segment for laboratory instruments in terms of instrument sales. It also is connected to the robotics/automation microplate readers for large batch spectroscopic analysis. This is one of the largest financial sectors in the analytical market and most definitely the largest in the burgeoning spectroscopic market. The division here is (i) Applications 5. (ii) Biochemistry 3. (iii) Instrumentation 3. (ix) Medical 11. (x) Nanodrop Products 1 (xi) Odds and Sods 3. The reason for this smallish number of publications is important to explain here. The reproducibility of the technologies is poor and researchers find it hard to replicate their results,

and hence good statistics for publications are difficult to generate. The use of these technologies for spectroscopic checks on purity of DNA and RNA is a massive market and these instruments generate good quality spectra which deliver a purity result from a spectral ratio measurement. These instruments are used for this quick QA check before considering the expensive processes such as of gene sequencing. Such QA are undertaken to remove DNA/RNA samples that would not be of a quality to generate a successful outcome. The technology in the opinion of the authors is of some importance to the COST MP1302 Nanospectroscopy project in that now these so-called nanospectrometers have pioneered a commercial front that other technologies can track and follow to the marketplace. In addition, nano-microfuidic technologies are advancing and these technologies connect to lab-on-a-chip techniques that are converging today with the main technologies represented in the COST Action (e.g.: SERS).

Review of Nanospectroscopy I Tübingen March 2014

The Tubingen March 2014 NanoSpectroscopy I Conference showcased the knowledge, expertise and capabilities of our Action. The report in Appendix File 8 attempts to answer a decision from the WG4 Meeting (minutes included) decided that the nanospectroscopy textbook should be based on the Action. The structure proposed from this report proposed a book structured of the Nanospectroscopy I Conference. This proposal is a practical and simple way of exploiting the collective capabilities of our Action in a rational way. The minutes of the WG4 meeting in Tubingen are also included in this Appendix File 8. While this report was not accepted by our editorial team as a basis for the structure and plan for the COST textbook, nevertheless is a very useful input to the planning of the textbook; it is an important snapshot in time of the state-of-the-art in Europe of our field.

Nanospectroscopy Journal

The spine of our textbook should perhaps come from the contributions that Professor Sebastian Mackowski has solicited for the new de Gruyter Nanospectroscopy journal. These and the review process for the papers will be important and very useful. Quoting “Nanospectroscopy is devoted to original and complete works on new methods or techniques to perform spectroscopy with a nanometric spatial resolution and to the investigation and discovery of new phenomena at the nanometer scale at the interface between physics, chemistry and biology. Nanospectroscopy will additionally offer both theoretical and experimental new developments in the rapidly expanding field of nanosciences.” Which is a well written statement that could be adapted for our submission to prospective publishers. The multidisciplinary nature of the new science is well served by the Open Access publishing model that opens to the new research community the published material in a way that can build new linkages between the diverse communities that would probably have little prospect of developing so effectively such dialogues in the more established publishing formats.

It is the authors’ proposal that these articles submitted from ‘Nanospectroscopy I’ Conference will provide a very strong guide as to the most dynamic members of our community and furthermore those with work seeking to move forward the new science. These papers are of particular importance in the planning of the WG4 textbook project.

After reviewing the contributions submitted to the Nanospectroscopy Journal, we will evaluate which relevant subjects of nanospectroscopy (if any) are either absent or under represented. In such a case we could consider seeking for external contributors to fill such gaps.

Pedagogical Structure for Textbooks Research

The thorny question is the one posed by Katrin Kneipp of the need for a pedagogical structure and to have the textbook written as a tutorial. We must ask now how do we address the issue of an overall educational delivery. This is a challenging point given the diversity range that must be integrated in the textbook. Quite obviously, some serious attention has to be given to the issue of pedagogical tutorial approach and structure. Despite considerable efforts through many hours of library research no adequate research has been uncovered. The only real work of modern

vintage and relevance to our MP1302 project is from the University of Novi Sad in Serbia. The work of Svetlana Španović in the Faculty of Education in Sombor has delivered a paper on the ‘Pedagogical Aspects of e-textbooks 14. This impressive publication contains only one paper on this issue which is included in Appendix File 9. Another interesting paper is included in ‘Planning science instruction’ by Gericke and Hagberg 15 and Vasilis Koulaidis and Anna Tsatsaroni 16 but both only disappointingly dealing with second-level. While there is disappointingly little here of value, these references are presented to highlight our dilemma and the urgency to find a cogent and relevant study that we can apply in our project.

The introductory chapter it is felt should tie the book together in giving a integrated well-balanced overview. This chapter has special pedagogical importance. We think this is a pretty standard conclusion from other textbooks The real issue is how do we make sure writers of chapters will tie in their approach to that being recommended by the editorial team? A very clearly worded document giving direction to authors is pretty standard, but given our need for 'Coherence' and we suggest something stronger here than just trotting along the old worn path might be considered.

There is unfortunately next to no 'directly relevant' research into 'pedagogical methods for textbook writing' and no studies into the efficacy of a 'pedagogical method' in an existing textbook to evaluate the effect of such an educationally based print teaching aids. Richard Palmer may have some useful insights/pointers here as his textbook series has a well-structured tutorial structure as well as Katrin Kneipp’s insights from her recent Wiley textbook project. We can presume some effort has gone into underpinning these textbooks with some educational theory. The editorial team unquestionably needs to give authors some clear guidelines so a consistent approach (Coherent is word used on our website) is ensured.

There are only very limited critical analysis of the function of textbooks in the educational literature; however, there obviously new dimensions to textbooks that should be considered at this stage. The conclusion here is that some serious work is required BEFORE the textbook contributors are requested for book chapters.

Hot Topics, Industrial Relevance and Knowledge Management

Whether we like it or not the importance of our textbook will also be judged on the basis of how it deals with ‘hot topics’. How industrial/commercially relevant its material is a judgement delivered often by ‘mere’ marketing people rather than our own expert community. The knowledge management that is standard practice in industry is something demanding our attention. Libraries, government agencies, information centres, etc. is a fairly new concept. The goal of KM is to share knowledge amongst those that make up the community in the spirit of learning, renewal and innovation. KM 17 is clearly a vital importance for our project. The importance of these issues must be flagged here as the very success of our project verily depends on the achieving of these deliverables to the readers.

We should start with understanding what exactly a ‘hot topic’ is. This is a subject demanding extensive and urgent discussion and debate. These topics impact on local and national economy, political issues, or in other ways that drive them to the front of debate. For nanospectroscopy while these issues will be important the most important ‘hot topics’ will sit at the centre of scientific advance in a field and perhaps will be rich in terms of rewards to the protagonists in delivering highly cited publications, success in grant funding, or the other practical issues widely recognized in our community. The accepted paradigm of the research communities has for a long time been recognized as a way of controlling the perspective of the research community and, somewhat worryingly, also controlling the positions of power within the community. We cannot ignore these issues, or if we do, it will condemn the WG4 project to being just another book that might occasionally be opened by an unsuspecting student not knowing better! Perish the thought!

The truth discover from talking with our Workgroup Chair Florian Kulzer was that our nanospectroscopy commercial dynamic is not very well developed. How could it be in such an emerging field as ours? It is something that will accelerate and perhaps the best push-start we can give is highlighting in the textbook topics of special industrial importance, not just merely relying on 'hot topics'. These files included in the various Appendix Files certainly give us a chance to identify ‘hot topics’, ‘industrial topics’ and importantly words that define what is seen as defining our research paradigms. These should perhaps be inescapable responsibilities on prospective authors to critically evaluate in drafting their contributions to the project!

Three Important Proposals

Katrin Kneipp has the expertise to be Editor-in-Chief, having been responsible for editing three recent textbooks directly relevant to this project. We make this suggestion here as this WG4 project should deliver a landmark publication then we clearly need the most able among us to take the lead. The Chair of WG4 will work with the editorial team who happily will do the heavy lifting, but it seems clear that if Katrin can be coached to take this role it would give the right cache to the publication. This is a very important strategic issue and not just window dressing.

The COST Action MP1302 should be looking at perhaps the importance of promoting work towards formulating new landmark spectroscopic protocols. In many areas the existing protocols such as the attached one in Appendix File 10 on the ASTM 'Spectroscopic Analysis of Petroleum Products and Lubricants' should see the opportunity of defining new protocols based on the collective expertise of the MP1302 Action. A superficial glance at this ASTM Protocol is useful and reveals a broad expertise is absolutely required for drafting such a protocol; this wide expertise probably exists collectively in the membership of our Action. The contributors to the textbook should therefore be asked to keep in mind the possibility of the Action proposing new spectroscopic protocols. It is entirely probable that given nanospectroscopy has a totally new set of technological solutions to problems such proposals would have some importance. Furthermore, the identification of such an Action deliverable would certainly be of lasting importance; even some preliminary discussion on these in the textbook might be a way of help in defining our new research paradigm. Such proposals certainly would raise an awareness of the future relevance of the work of those involved in the Action and the writing of our textbook. It is worth mentioning, that ASTM protocols are what could euphemistically be described as 'low handing fruit'; the protocols are based on old technologies that are today being rapidly superseded and Europe should be thinking of perhaps pushing ahead here of proposing Euro-nanoprotocols.

The textbook in short must strive to be a paradigm setter and this proposal is just one such suggestion that our contributors could give some thought to in writing their chapters. It would be advisable that such things as 'Hot topics' 'Industrial issues', 'Protocol horizons' etc. are collectively used to sharpen the appreciation of the prospective readership to our textbooks relevance.

The third proposal is that the offer of the two Institute of Technology Carlow librarians Simon Perry and Ronan Lynch to help properly establish the library research and support for this project should be accepted. A professional contribution is desirable to assist the editorial team in ensuring that the material is written at the correct 'reading' undergraduate level, that chapters

internally and externally are consistent, and most importantly that all the material is integrated in a satisfactory way into a properly planned tutorial structure. A considerable amount of this essential editorial planning could be assisted by professionals who have a totally different viewpoint to the experts in nanospectroscopy.

Timetable

This needs to be decided at the earliest opportunity and the authors suggest 1st September 2014.

Conclusions

The way forward to the submission from this report needs some real urgency. The first task is to work from this report to establish what the editors can agree.

The WG4 members perhaps should be consulted and given an opportunity to input to the present report and volunteer for writing chapters, joining the editorial committee etc.

There are some areas that need more research at this stage; one glaring issue is the pedagogical structure.

After review of this document by the WG4 Chair and co-editors, the next steps towards submitting the proposal to publishers are:

- To produce a first draft content by Drs McMillan and Rodriguez, based on the researched material,
- Critical evaluation of draft by editorial team
- Report when tidied sent to WG4 members
- Draft proposal produced on content and structure
- Editorial committee to finalise this
- Report sent to WG4 members for comment

- Professor Kneipp to lead discussions on the lead contributors for the chapters and get them committed
- Contributors to tidy up chapter outlines for a finished proposal
- Editorial team having done the preparatory work on the submission to finalise the details in the light of the material they need
- Proposals tailored for each publisher and sent synchronously to all the various publishers
- Strategic plan decided on the production and responsibilities of the editing/production

The vote on any proposals coming from publishers will need to be considered but the decision should ultimately rest with the editorial committee.

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Appendices

Appendix 1: Rules of Presentation

Rule of Frameworks: Memory and understanding are promoted by the use of a structure that mimics the structures we all use within our minds to store information. Before we can use or master a subject, we have to have a mental roadmap that allows us to navigate within and through the subject domain. The text can best aid understanding by making this framework visible early on within each section or topic. The extent to which the student understands that they are using a framework, and knows what that framework is, is important as they internalize and make use of the material presented.

Rule of Meaningful Names: Everything we know is tagged with an index or a title. These indices are critical to the ability to recall or retrieve the things we know and remember. Each concept, process, technique or fact presented should aid the student to assign a meaningful name for it in their own mental organization of the material. To be most useful, these names shouldn't have to be relearned at higher levels of study. The names assigned by the text should

be useful in that they support some future activities: communication with other practitioners, reference within the text to earlier mastered material, and conformity to the framework used for the subject. Each unique element of the subject domain should have a unique name, and each name should be used for only one element.

Rule of Manageable Numbers: When we learn from an outline, an illustration, or an example; most of us are limited in our ability to absorb new material. As we become familiar with part of a subject domain this number expands, but for new material four to six new elements is a reasonable limit. If a chapter outline contains 12 items, the student will have forgotten the outline before getting to the last item. When a text fails to support this rule, it requires even a diligent student to needlessly repeat material.

Rule of Hierarchy: Our mental frameworks are hierarchical. Learning is aided by using the student's ability to couple or link new material with that already mastered. When presenting new domains for hierarchical understanding, the rules for meaningful names and manageable numbers have increased importance and more limited application. A maximum of three levels of hierarchy should be presented at one time. The root should be already mastered, the current element under consideration clearly examined, and lower levels outlined only to the extent that they help the student understand the scope or importance of the current element. This area is supplemented by two more rules within this rule: those of Connectivity and Cohesion. Connectivity requires consideration of what the student likely knows at this point. The more already mastered elements that one can connect with a new element, the easier it is to retain. Cohesion requires that the characteristics of new elements as they are presented be tightly coupled.

Rule of Repetition: Most people learn by repetition, and only a few with native genius can achieve mastery without it. There is a pattern of repetition that aids in promoting the elements of a subject from short-term to long-term memory. Implementations of this rule may mean that frameworks and important hierarchies are repeated as many as five or six times, while frequently used elements are repeated three or four times, and elements of lesser utility may not be repeated at all. The first repetition should normally occur within a day of first presentation, followed by a gradually decreasing frequency. Exercises and review sections are ideally contribute a designed repetition pattern.