A COMPARISON OF THE INFORMATION SEEKING PATTERNS OF RESEARCHERS IN THE PHYSICAL AND SOCIAL SCIENCES

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The information seeking patterns of a group of research physicists and research chemists were analysed and the key features of those patterns identified. The aim was to use a similar methodology to that employed in a previous study of the information seeking activities of a group of social scientists and to effect a comparison between the information seeking patterns of the scientists and the social scientists. The information seeking patterns were derived from interviews with physicists at Manchester University and chemists at the University of Sheffield. The methodology adopted for the interviews and analysis was qualitative and based on the grounded theory approach. The results were then compared with the findings of the previous study of the social scientists to try and identify similarities and differences between the two groups. Certain minor variations concerned with awareness levels of facilities, the extent of usage of a source and the research stage at which a strategy may be employed were identified. Nonetheless, fundamental differences in information seeking behaviour could not be determined. Finally, the extent to which developments in electronic communication have had any impact on the information or communication patterns of the scientists and social scientists is considered.

INTRODUCTION

THE STUDY OF THE INFORMATION SEEKING BEHAVIOUR of scientists can be dated back to the late 1940s [1]. Since that time, a large number of studies have been carried out on various aspects of the information seeking behaviour of scientists and this literature has been extensively reviewed. There is also a considerable literature on the information seeking behaviour of social scientists which also has been comprehensively reviewed. However, there has been far less in the way of comparison of the information seeking activities of these two groups and only a small number of studies have addressed this issue [2–6]. Part of the reason for the paucity of comparative studies of the two groups may be that the various studies of information seeking behaviour differ so widely in aims, objectives and methods that genuine comparison of the results is virtually impossible. As Skelton noted:

> The literature of science user studies is composed of a large body of data that cannot be correlated, due to differing objectives, methodologies, samples, scales and definitions used by the studies. Each study stands in

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> isolation, with no obvious links that enable it to be compared with other studies [6, p.139].

Furthermore, many of the studies display a rather shallow conceptualisation as Mole [7] commented in his review of Slater's [8] study of the information needs of social scientists:

> [The study] lacks any explicit theoretical framework which might guide the research or enable one to interpret the findings in a meaningful fashion. More useful would be detailed case studies of information use in specific organisations or specific professions, especially if it showed awareness not only of social science methods (including textual analysis) but of social science theories [7, p. 40].

The main aim of the research described here was to attempt to rectify these defects. On a small scale it was hoped to demonstrate that it is possible to apply a method of investigation in user studies which can be employed to obtain comparable results across a range of different subject groups and which does connect with a well established approach to theoretical model building in the social sciences. Firstly, this was done by studying the information seeking patterns of scientists employing the same approach and methodology as that used in an investigation of the information seeking patterns of social scientists, and secondly, by employing the grounded theory approach [9] in the study of the information seeking activities of the two groups. The objective was to derive behavioural models of the information seeking patterns of academic physicists [10] and academic chemists [11] employing a method similar to that used by Ellis [12–14] in deriving a behavioural model of the information seeking patterns of academic social scientists.

Information on the information seeking activities of the scientists was collected by means of personal interviews with eighteen physicists and fourteen chemists. The interviews adopted the interview guide approach [15] employing an interview guide based on that used by Ellis. The interviews themselves lasted forty-five minutes to an hour. The analysis of the results of the interviews employed the constant comparative method of analysis outlined by Glaser and Strauss [9].

The sample of physicists was drawn from the Manchester University and University of Manchester Institute for Science and Technology (UMIST) Physics Departments. Initial contact was made with the laser group at Manchester University and respondents were drawn from the subject area of atomic, molecular and polymer physics which incorporated the majority of the sample. Further smaller samples drew upon physicists in the low temperature group and the nuclear physics group. All of the researchers were experimentalists – with the exception of the last one interviewed who was a theoretician in astronomy. The inclusion of a theoretician was considered relevant to ensure that a possible difference between experimentalist and theoretician was not completely excluded; this consideration only emerged as the project progressed and it was not possible in the time frame of the project to explore this more fully.

The first group to be interviewed were all members of the atomic, molecular and polymer physics group. This large group allowed for the comparison of emergent data from the members of other groups within the field. The sampling aimed to ensure variation in substantive topic within the field (Appendix 1) and to include researchers with different levels of experience. The sample was made up of ten full-time PhD research students – four first year, five second year, and one third year – one part-time PhD research student, six post-doctoral researchers, and the head of the laser group. In terms of research experience just over half of the sample were full-time PhD research students, while all eight of the other physicists had over four years' research experience, with one subject having twenty five years' experience in research. In terms of teaching experience three of the sample were lecturers and seven were postgraduate teachers.

The interviews covered both the information gathering and information diffusion activities of the researchers. However, as the principal focus of this project was the information seeking behaviour of the physicists, the information diffusing activity was not included in the emergent core categories. Other concepts which were identified in the initial analysis were absorbed into the core categories as the analysis proceeded. These subsumed concepts were treated as sub-patterns of the core categories. In all five core categories were derived to explain the information gathering activities of the physicists: initial familiarisation; chasing; source prioritisation; maintaining awareness; and locating.

Initial familiarisation encompasses activities undertaken in the earliest stages of the information seeking process. Chasing covers the activities engaged in when following up citation links between material and identifies the criteria of selection employed for both backward and forward chasing. Source prioritisation refers to the physicists' views of the importance of the various sources available. Maintaining awareness explores the activity of keeping up-to-date in the researcher's own area and in the field as a whole. Finally, locating encompasses the activities engaged in when actually finding the information.

The sample of academic chemists was selected from the Department of Chemistry at the University of Sheffield. An initial group of twenty non-professorial academic chemists, selected from the Departmental staff list were contacted and invited to take part in the study. The candidates were selected from the four branches of chemistry represented at Sheffield: organic, inorganic, physical and theoretical chemistry (Appendix 2). The small size of the sample means that it is not possible to make meaningful comparisons between the information seeking behaviour in the various branches of chemistry. However, the different natures of the different branches of chemistry represented at Sheffield helped to overcome the risk of a pattern of behaviour being omitted. Of the twenty chemists contacted fourteen interviews were arranged. Five chemists declined to be interviewed, four on the grounds of pressure of work and one on the grounds of his semi-retired status. It proved impossible to contact one chemist – it later transpired that he had retired.

Eight categories seemed sufficient to describe the information seeking activities of the chemists: starting; chaining; browsing; differentiating; monitoring; extracting; verifying; ending. Since the nomenclature and definition of the categories were standardised with those of Ellis, the first six categories, which are also found in Ellis's model, can be defined using the following definitions:

starting: activities characteristic of the initial search for information;

chaining: following chains of citations or other forms of referential connection between material;

browsing: semi-directed searching in an area of potential interest;

differentiating: using differences between sources as filters on the nature and quality of the material examined;

monitoring: maintaining awareness of developments in a field through the monitoring of particular sources;

extracting: systematically working through a particular source to locate material of interest.

The categories verifying and ending are novel and can be defined as:

verifying: activities associated with checking the accuracy of information;

ending: activities characteristic of information seeking at the end of a topic or project, for example, during the preparation of papers for publication.

As with Ellis's model of the information seeking patterns of the social scientists, the models of the information seeking patterns of the physicists and the chemists can be used to describe any individual pattern of information seeking behaviour. However, the models do not attempt to define the interactions and interrelationships between the categories or the order in which they are carried out. The nature of the relationship between the features of the models can only be described in relation to specific information seeking patterns. Therefore, although it is possible to describe relationships between the features at a general level, the exact relationship of the features of the models depends upon the circumstances associated with the information seeking behaviour of a particular individual at a particular time.

COMPARISON OF THE INFORMATION SEEKING PATTERNS OF THE PHYSICISTS, CHEMISTS AND SOCIAL SCIENTISTS

The model of the information seeking patterns of the physicists employed categories which differed in terminology from those of the original study of the social scientists, while the nomenclature used for the categories in the study of the chemists was standardised with that of the study of the social scientists to facilitate the easier comparison of the two models. In the comparison of the information seeking patterns of the physicists, chemists and social scientists

outlined here it is intended to employ the terms for the categories used in the study of the chemists – which were derived, in the main, from the study of the social scientists – and to cross reference the activities described to the categories employed in the study of the physicists. This represents a form of validity check on the empirical soundness of the models, as the terms employed in the models may differ while the underlying pattern of activities is the same.

Starting

The core category of initial familiarisation, from the study of the physicists, displayed a basic similarity with Ellis's category of starting. Ellis described starting as encompassing activities characteristic of the initial search for information. The study of the physicists employed the category initial familiarisation to refer to the starting points adopted when the researcher begins seeking information for a new or unfamiliar project. The definitions of these two categories are, therefore, similar and, in consequence, a direct close comparison between the two can be made.

All of the physicists interviewed had employed personal contact as a starting point for approaching a new topic. Several of the physicists who were in the process of PhD research mentioned that they had been provided with their initial references by their supervisors and explicit reference to the provision of starter references was made as part of the role of supervision. The physicists, like the social scientists, were often already aware of key references or key people in a new area and their natural tendency was to begin with material with which they were already familiar. Although there seemed to be variations between the physicists and the social scientists in terms of the level of awareness of computer based information services and opinion of the utility of the output, and the use of formal literature searching tools appeared to be higher amongst the physicists, for the most part initial familiarisation or starting behaviour was similar for the two groups.

In a similar way, the resources used by academic chemists for starting – starter references; informal contacts; reviews or review type material; and secondary services – were identical to those used by the social scientists. However, while the same resources were used, and while both groups seemed to rely equally heavily on starter references, reviews and informal contact when starting, the chemists seemed, on the whole, to make more use of secondary services when starting than the social scientists.

Chaining

The second generic characteristic identified by Ellis as a key feature of the information seeking patterns of the social scientists was that of chaining – following citation connections between material. This activity was also recognised as a feature of the information seeking activities of the physicists and was given a similar label – chasing. Backward chaining, with the physicists as with the social scientists, was identified as the principal means employed to chase references. All the physicists interviewed stated that they followed up

references cited in material consulted. The physicists also used backward chaining as part of the maintaining awareness activity. As with the social scientists, forward chaining was less widely used and understood, but of the physicists who were aware of the existence of citation indexes, most had employed the technique of forward chaining.

The main difference between the physicists and the social scientists was the higher level of awareness amongst the physicists of the existence of the *Science Citation Index*, compared to that of the social scientists of the *Social Science Citation Index*. Most of the social scientists were unaware of the existence of citation indexes. In contrast, only a minority of the physicists did not know what a citation index was, and use of *Science Citation Index* was mentioned by half of the physicists, although those that did use it did not do so on a regular basis. This also contrasts with the chemists, all of whom were familiar with the existence of the *Science Citation Index*; five made regular use of it, half used it occasionally, and only two never used it. Some remarked that it was particularly useful in that it allowed the search to proceed in the opposite direction to *Chemical Abstracts*, that is, to forward chain.

Browsing

Browsing, in the sense of semi-directed or semi-structured searching in an area of potential interest, was an activity which most of the social scientists had engaged in at some time. Evidence that browsing, understood in the same sense, was an activity of the physicists can be drawn from several of the core categories. In the initial familiarisation process several of the physicists stated that they would start looking for information on a new topic by doing a literature search. The aim of the literature search would be to obtain abstracts and to browse those abstracts in the hope of finding relevant papers which could then be used as a basis for chasing references, and the browsing of computer abstracts was mentioned by several of the researchers. This type of browsing was mainly engaged in by the physicists in the initial familiarisation stage, but browsing was not confined solely to this stage. Browsing to maintain awareness was also mentioned in a description of scanning journals as a preferred method of keeping up-to-date and one of the physicists mentioned having an ongoing update from a computer search which he then browsed.

Various methods of browsing were used by the chemists. These included browsing in journals or *Current Contents*, in abstracts, along the shelves in the library or in bookshops, and the book and poster displays at conferences. The methods described by the chemists are similar to those mentioned by Ellis for the social scientists. Ellis noted that for browsing to be effective some limits have to be placed on the area to be searched and related material should be grouped together; similarly for browsing the chemists relied on the related material being grouped together: as one of the chemists remarked: 'You know roughly where the subject areas are through classification – that does break down – but you know roughly where and you just go and have a look'.

As with the social scientists browsing was also used for current awareness. The two main approaches for this mentioned by the chemists were browsing

Current Contents and browsing in bookshops to see what was new, especially in the way of textbooks. However, although many of the chemists used browsing, this did not appear to be a major feature of their information gathering activities.

Differentiating

Ellis defined differentiating as an activity which uses differences between sources as a filter on the nature and quality of the material examined. A comparison between the activities of the physicists and the social scientists in this respect can be drawn from the category of source prioritisation, which was concerned with the factors influencing the choice of source selected by the physicists. Ellis found that the criteria used by the social scientists for the selection of their core journals centred around three main factors – the substantive topic of study, the perspective or approach adopted, and the quality, level or type of treatment.

The physicists, like the social scientists, differentiated between sources on the basis of their substantive topic, and they clearly identified those sources which focussed particularly on their own subject and those which regularly carried material on a topic of interest. Core journals represent for the physicists, as for the social scientists, a means of identifying relevant material. Several of the physicists clearly identified their section of a particular journal set. The credibility of quality of published material was judged in part by the journal source; an additional measure of credibility involved respondent confidence in the author. On the basis of this comparison between the activities of the physicists and the social scientists it seemed that the concept of differentiating between sources to filter material on the basis of quality, level and type of source was appropriate to both groups.

The criteria used by the chemists for differentiating were: the topic of the material; author; quality; level and type of source, and language. All the chemists were able to name the journals which were of particular importance in their fields. Some pointed out that the list of relevant journals was not static but changed with factors such as time and editorial policy. Similarly, in chemistry, as in social science, there is an unwritten pecking order of journals, with some journals being perceived as of a higher quality than others. Several chemists used the perceived quality of the source to differentiate material, with some mentioning the degree of stringency of refereeing of a journal as being an important factor in whether they would follow up material in that journal. Several mentioned that they followed the work of particular authors and one used his opinion of the quality of an author quite aggressively to filter material.

Monitoring

Ellis defined monitoring as the activity of maintaining awareness of developments in an area through regularly following particular sources. Comparative material for the physicists has, therefore, been derived from the maintaining awareness category as the definitions are considered to be similar.

There were some differences in the principal sources used for monitoring though both groups used personal contact and journals as important sources. The physicists, like the social scientists, were usually aware of the core sources and monitored a small number carefully – in the case of the physicists these were mainly journals, *Current Contents*, and printout from online searches. As was the case with the social scientists, only a minority of the physicists had a wide ranging approach and monitored a large number of sources.

Unlike the social scientists, the physicists made no mention of the use of books for maintaining awareness. Standard texts and introductory textbooks were employed by a majority of the physicists in the initial familiarisation process, but for monitoring developments in the field, books, as a whole, were considered too out of date. Similarly, newspapers and publishers' catalogues, which featured amongst the social scientists' responses, were not evident in those of the physicists. The physicists preferred to employ conferences, conference proceedings, magazines and computer search updates. Books which were mentioned for maintaining awareness by the social scientists did not feature in the physicists' responses. This comparison, therefore, revealed some differences between the social scientists and the physicists in the principal sources used to keep up to date but not in the overall nature and form of the activity.

In relation to monitoring, the chemists were principally interested in keeping up to date in their own topics and fields, although, as with the social scientists, they also had a more general interest in keeping up with developments in chemistry and science as a whole. For both groups informal contacts were identified as an important source for keeping up to date. The chemists monitored various published sources – journals, abstracts, books, newspapers and television – similar sources to those monitored by the social scientists. However, a difference does emerge in relation to the monitoring of published material in that the chemists mainly monitored journals while, taken as a whole, the social scientists monitored journals and books approximately equally. These findings agree well with previous work by Skelton [6] who found that while scientists tended to rely on journals, social scientist used monographs and journals equally. Another difference was that, while some of the social scientists made some use of the quality press to alert them to information, most of the chemists mentioned only minor use of the quality press, particularly *The Independent*, and television as a source of information, and that for only general information on chemistry and science as a whole.

Current Contents provides an alternative to scanning the journals themselves and might be expected to be particularly useful for journals not available locally. However, use of *Current Contents* was not found to be a regular part of the monitoring activities of most of the chemists. Two had never used it, others used it only occasionally, some indicating that their use of it was reduced because it was only available on another site. One chemist made use of the *Bi-weekly List of Papers on Radiation Chemistry and Photochemistry* produced by the University of Notre Dame rather than

Current Contents or other secondary services. There were mixed opinions on the usefulness of *Current Contents* – where it was perceived as being valuable was for monitoring journals to which the library had cancelled subscriptions. None of the chemists used *Chemical Abstracts* for monitoring; however, some did make use of the *Chemical Abstracts Selects* relevant to their area in this role. Another secondary source used occasionally in this role by one chemist was *Dissertation Abstracts*. In addition to monitoring journals relevant to their topics many chemists mentioned reading general journals for general scientific information. Journals mentioned as suitable for this included *Chemistry in Britain, New Scientist* and *Nature*.

Extracting

Evidence for the activity of extracting amongst the physicists interviewed was minimal. Extracting as a focussed behaviour of going through a particular source and selectively identifying material from that source only really occurred at the initial familiarisation stage. This involved working through a variety of sources to identify material in those sources. These included working through sets of journals, series of monographs, collections of indexes, abstracts or bibliographies and computer databases. Large scale retrospective searching did not seem to be a characteristic of the information seeking activities of the physicists except for the retrospective searching at the initial familiarisation stage. The concept of the physicist searching an archive for new material once immersed in a project did not really arise, as once the physicist is familiar with the work retrospective searching is an activity which rarely occurs. The circumstances under which it might were falling behind in the monitoring of a chosen journal, or, possibly, for gaining a broader information or knowledge base than is necessary for the task or project in hand.

Extracting was not found to be a particularly significant activity for the chemists. The major use seemed to be for writing review articles. However, as with the social scientists and physicists it was mentioned as a means of updating if monitoring had lapsed. Several chemists indicated that they found it difficult to maintain regular monitoring of journals but that writing review articles forced them to go through the literature bringing themselves up to date. For one chemist extracting to write an annual review had almost completely replaced monitoring. The sources used by the chemists for extracting were principally journals and abstracts.

Verifying

Verifying is a category of behaviour which was not identified as a discrete category in Ellis's study. Although similar activities were mentioned by some social scientists it was a very minor part of those activities and would have been subsumed under chaining. In contrast, most of the chemists indicated that they were aware of the possibility of errors, particularly typographical errors, occurring in their information. Errors in numerical data were the most commonly cited – although other errors, for example in citations, nuclear

magnetic resonance (NMR) assignments and equations were also mentioned. Several indicated that they either did not check their information or only checked obvious errors. However, one chemist did a spot check on everything, as well as checking obvious errors and material from sources he regarded as unreliable; another did a spot check on new textbooks. Some attempted to verify all their information, if possible, while one stressed verifying information from sources he perceived to be unreliable, for example, in textbooks or reviews.

Ending

Another activity which was not identified as a discrete category in Ellis's study was that of ending, although again similar activities were mentioned by some social scientists – particularly in relation to starting. Most of the chemists did their major information gathering at the start of or during the lifetime of a project; however, several mentioned returning to the literature at the writing up stage when they needed to discuss their work in the light of other published work. Two chemists indicated that they performed major literature searching at the end of a project. In both these cases information gathering at the start of the project was minimal. One of these two indicated that he would go to the literature as necessary during the lifetime of the project; the other, however, did not return to the literature until the completion of the work, although they both used monitoring during the lifetime of the project. Both were aware of dangers with this type of approach in finding material at the end which would have led them to modify the work they had carried out or in finding that the work had already been undertaken.

CONCLUSION

The comparison of the information seeking patterns of the physicists and the social scientists shows no overriding differences between the two groups. The groups undertake similar activities and the sources employed are also similar. Although the extent of usage of a source and the stage at which a particular characteristic may be employed may differ, the characteristics of the information seeking patterns of the physicists and the social scientists are fundamentally the same. The main difference between the models of the information seeking patterns of the chemists and the social scientists is the existence of two extra categories of behaviour – verifying and ending – which were not identified as discrete categories for the social scientists, although some social scientists did report similar activities which were subsumed under the categories of starting and chaining. Of the two, verifying was used regularly by a majority of the chemists interviewed, and, in that respect, seems to indicate a generic difference. Some social scientists did report similar activities but these were treated as a sub-aspect of chaining. As only two of the chemists made significant use of ending this can be seen as a rather minor category, and in the case of the social scientists similar activities were subsumed under other categories, in particular, that of starting. Overall, the

differences between the information seeking activities of the chemists and social scientists seemed more a difference of emphasis than of a fundamental difference in behaviour.

The studies reveal a remarkable degree of homogeneity between the information seeking patterns of the physicists, chemists and the social scientists, both in terms of the information seeking activities reported and and the researchers' perceptions of those activities. The findings confirm the broad conclusions of previous studies by Garvey *et al.* [2–4] and Skelton [6] that there are not major differences in the information seeking activities of social scientists and scientists although there are differences of emphasis. It is interesting to note that neither are there major differences in the perceptions of those activities between the three groups. The comments on personal contacts, reviews, chaining, differentiating and monitoring sources, and the perceptions of the different values of books, journals and conferences are virtually interchangeable between the physicists, the chemists and the social scientists. The comments on the value of secondary services such as abstracts and indexes are almost so, although here a noticeable difference in the perception of the value of secondary services by the scientists compared to the social scientists does become apparent – particularly in relation to sources such as *Chemical Abstracts*.

It is also interesting to note the relatively minor impact which developments in information technology have had on the information seeking and communication activities of the three groups. While some researchers have employed electronic means of identifying references, this has usually only constituted a small part of their information seeking activities. In relation to the communication of research, the employment of electronic communication as a complement to or substitute for the traditional forms is, as far as can be discerned, virtually non-existent. This confirms the observation of Meadows and Buckle [16] that although the potential for electronic communication of research in the form of electronic conferences and journals has been widely discussed (see for example papers in Feeny and Merry [17], in particular those of Richardson [18] and Van Halm [19]) and despite the technical feasibility of this form of communication as demonstrated in projects such as BLEND [20] and Quartet [21], the impact on the scientific communication of academic research, at least in the UK, has remained negligible.

There does appear to be increasing interest in the USA in electronic communication of research results in the form of electronic conferences [22–25] and journals but it seems unlikely that this form of communication will displace traditional conference and journal publication – at least in the near future – partly because of the role of conferences in creating and maintaining personal contact but also because of the lack of formal recognition of electronic media as representing legitimate outlets for publication. The explanation for this is connected to the professional norms of academic publication by which the refereeing process is employed to legitimate contributions to knowledge [26–27]. This is strongly the case for academic journals and operates in a similar fashion, if rather more loosely, in the

selection of papers for conferences. In this respect it will be interesting to see whether the appearance of peer reviewed electronic journals such as *EJournal, Electronic Journal of Communication, Journal of the International Academy of Hospitality Research, New Horizons in Adult Education, Postmodern Culture,* or *Psycoloquy* [28] will do anything to alter the dominance of the traditional forms of scientific publication and communication or whether these sources will simply be marginalised and be perceived as representing lower division outlets for minor league research.

APPENDIX 1

Research interests of physicists
Laser gyroscopes
Ring lasers
Fibre lasers
All aspects of laser physics
Experimental research in laser physics
Molecular physics
Non-linear optics
Medical lasers
Liquid crystal displays
Liquid crystals
Medical application of lasers
Nuclear physics
Patterns in helium 3
Convection in liquid helium and mixtures at cryogenic temperatures
Low temperature physics
Low temperature helium
Charge transfer processes in clouds leading to thunder-storm electrification
Theoretical astronomy – variable winds around Wolf Ray stars

APPENDIX 2

Research interests of chemists
Liquid crystals, especially metal containing liquid crystals; non-linear optics
Investigation of structure, especially the dynamic mechanisms of inorganic and organometallic compounds, using nuclear magnetic resonance
X-ray diffraction determination of crystal structures, especially oxide systems, distortions in high symmetry systems and peroscites
Organometallic chemistry, catalysis, chirality, new materials and their applications
Bio-inorganic chemistry, modelling biologically active sites using small molecules, chemistry of macrocyclic ligands and metal complexes
Organometallic chemistry, particularly carbine complexes
Biological organic chemistry, nucleic acids, enzymes, drug development, catalytic antibodies

Radiation chemistry, photochemistry
Computer simulation and theoretical investigation of the properties of bulk fluids
Biophysical chemistry, protein stability, interaction of primary metabolites with secondary metabolites
Thermodynamics and surface behaviours of liquids and liquid mixtures
Structure, spectra and properties of molecules
Theoretician studying breakdown of normal models of molecular structure in large molecules, especially organometallics
Quantum chemistry, theoretical aspects of non-linear optics

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