

## Chapter 3--The Physicists

### *Description of the Physics Department*

The Physics Department at the University of Maryland (UMD) has one the largest physics research programs in the United States. According to the National Academy of Sciences, The UMD doctoral program in physics is ranked first among all public universities on the East Coast, eighth among all public universities and eighteenth overall, nationwide.<sup>8</sup> The Gourman report (1996) ranks it nineteenth nationwide, among the leading graduate programs in physics. UMD's Physics Department supports twelve experimental groups and seven theoretical groups including space physics, nuclear physics, high energy physics with accelerators, plasma physics, condensed matter, materials research science, and quantum electronics to name a few. The Physics Departments's Center for Superconductivity Research has an independent budget of over two million dollars. The faculty in physics have research involvements with many groups on and near the campus. These include the Goddard program for astrophysics and solar physics, the Fermi Lab and the Naval Research Lab. Several multidisciplinary institutes such as the Institute for Physical Science and Technology and the Institute for Advanced Computing Studies include physicists whose work overlaps with other disciplines.

There are about seventy-five tenure-track and tenured faculty members in the department. They have thirteen professors emeriti, twenty-five research scientists, sixty research associates, and seventy faculty research assistants. In addition to the twenty million dollars that the department receives in state funds, its researchers are funded by over seventeen million dollars in funds from external grants from foundations, national laboratories, the National Science Foundation and the Department of Energy, among other sources.<sup>9</sup>

### *Interview Format*

I began by talking to the chairman of the department, Dr. Stephen J. Wallace, explaining

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<sup>8</sup>From the UMD Physics Department web pages.  
Available:<http://www.physics.umd.edu/deptinfo/physfact/ranking.html>

<sup>9</sup>From the UMD Physics Department web pages.  
Available:<http://www.physics.umd.edu/deptinfo/physfact/budget.html>

my thesis topic and indicating my desire to interview six physicists. He gave me the names of several researchers including both experimentalists and theoreticians who might be able to meet with me. His only comment about the e-print servers was that many of the younger members of the department enjoyed using them. I set up all six interviews using e-mail, and, in most cases, I sent out a set of questions to each researcher before meeting with them, so that they could have the opportunity to think about them. (Appendix B) Two of the people declined to be interviewed, so I just took my chances and sent off e-mails to several professors named on the UMD Physics website. This method worked well. To see a list of those interviewed see Appendix C. The interviews, lasting about thirty minutes, were taped. In some cases I followed the questions in the exact order as they appear in Appendix B, but in most cases, I used the questions as a guide. Often I digressed and delved into other areas that promised new information. In all cases, I received permission from the interviewees to use their names.

***Dr. Thomas D. Cohen***

Dr. Thomas D. Cohen is a full professor with both teaching and research responsibilities. He is a theoretical nuclear and particle physicist. When I asked about the difference between the high energy theorists and experimentalists, he explained that these two groups have completely different cultures. Jokingly, a theorist might refer to an experimentalist as a “technician.” They build on each others work, however, and he sometimes reads experimental papers to follow the field. He explained the difference between high energy theoretical work and high energy phenomenological work, relating it to the type of question to be investigated. While some theorists might be involved in very “high brow” ivory tower work using mathematics to explain the theory of everything, the phenomenologist would be working with ideas that can be measured by experimentalists. He placed his own area in the more practical realm. His work never involves patents, and he is not under any publication constraints from those who fund his research. He has published six papers in the last five years, preferring to submit to *Physical Review C* and *D* published by the APS or *Nuclear Physics A* and *Physics Letters*, which are European publications of North Holland Publishing. He submits his papers electronically and uses the software called LaTeX.

In Dr. Cohen’s field, the e-print servers at Los Alamos are used extensively. The hard

copy archival journals resting on the shelves in the library have become almost completely irrelevant to his work. Even full-text online journal databases that the library subscribes to and which can be accessed from any computer on campus are not very important. In most cases in his field, he would not need to read any journal articles older than four or five years, and for those, he gets them online from the e-print servers. “The e-print servers have changed the culture considerably in terms of timeliness...For example, I submitted a couple of papers with a fellow in August, and by October we had twelve citations which is more than I had as a post-doc!” (Thomas D. Cohen, personal communication, December 17, 1998. All the quotes in the following section refer to his comments during the interview) Typically, Dr. Cohen will submit a manuscript for review simultaneously with submitting it to an e-print server. The author decides where to post the manuscript according to the subject matter. For example, in Dr. Cohen’s case, he might send a paper to the hep-th server and cross-list it on the nuc-th server. When asked if he expected feedback or the need to revise the work, he stated that the manuscript is sent out as a finished work, but it functions as a draft. “Several things can happen that are useful:

1. Someone e-mails you complaining that you failed to cite their paper. That’s actually not a trivial complaint, and that’s probably the most common response.

2. Somebody writes to you and says, ‘I don’t understand equation seven. Do you mean this? You go back and realize that you need to clarify it by adding a paragraph.

3. Or, someone will say there’s a typo on equation 14, you dropped a factor of 2 and that’s actually very helpful. It provides community wide referring in the sense that before you finalize it, you can make changes in response to the comments.”

When I commented on the willingness of the APS to work with the archives by cross-referencing articles and lifting them from the servers with the preprint archive number to send them out for review, Dr. Cohen’s comment was that they had no choice. “The way business is really done now, at least in my field,...the journals are merely serving an archival function and somewhat of a quality control function, because of the refereeing. That’s somewhat useful, but I’m actually more of a cynic about that, in the sense that, basically, bad papers will die a natural death, anyway. They will just be ignored.”

Dr. Cohen feels that posting manuscripts in the e-print archives establishes priority for his

ideas. It places them squarely in the public domain for all to read, and each entry is dated and recorded. When I asked if he feared that some of his ideas might be “scooped” from the e-print servers, he replied that the concern was just the opposite. As a theorist, by delaying to get the work ready and posted on the e-print archives, someone might anticipate his work and be first at getting it out on the archives. Clearly in his field, the archives are functioning as the place to establish priority. Once a work is submitted, the documentation is clear to everyone, establishing when it was posted and who put it out there first.

Are referees and editors of *Physical Review C* and *D* reading the archives in his field and commenting on them? “Yes, that’s very common, and becoming more so. And the reason is because of the time scale of work. In a field that moves very rapidly in the course of a year, all the important papers will be read first on the e-print servers.” As in most scientific publication, the people writing the content of the publications are the same people who are consumers of the information. The same group of people are called upon to serve as referees because they know the field and can evaluate manuscripts. It makes sense that among the nuclear and particle theorist community, the referees would have to keep current with the articles that appear first on the e-print servers just to keep abreast in their field. He cites the e-prints in his manuscripts and refers colleagues to specific e-prints at conferences.

The high energy scientists have added one feature to their servers that other fields in physics have not. The Stanford Library citation indexing (SPIRES) database that tracks thousands of preprints for the particle physics community is linked to Ginsparg’s servers. This allows that community to follow hyperlinks from one paper to the full content of papers that have been referenced in the text as well as linking to the full content of all papers that have cited that particular preprint. Dr. Cohen never bothers with the online physics journals or even references to forthcoming accepted manuscripts that are posted on the journal web pages because that information is already dated: “The reason is because I go to the e-print servers daily. I know the people in my field, and everyone in my field posts their papers here. That wasn’t true two or three years ago, but now it is.”

In the beginning, Dr. Cohen did not find e-prints technically easy to use. The first time he submitted a paper, it was because his co-author, who was one of his post-doctoral students, was

more savvy about computers and urged him along. He still finds TeX rather painful. In the beginning, he had trouble getting his computer set up so that he could easily read and print postscript files and unzip files. It was not until the department hired some computer specialists that he was able to get everything configured properly and get the right browser loaded. “The servers are set up for computer sophisticates rather than people like me.”

### ***Dr. Drew Baden***

Dr. Drew Baden is an experimental particle physicist who divides his time between the University of Maryland and trips to the Fermi Lab in Chicago to work on the accelerator there. His graduate students and post docs are all in Chicago. When I asked him about the difference between experimentalists and theorists, his comment was, “ We do experiments, and they just calculate stuff” (Drew Baden, personal communication, December 14, 1998. All quotes in this section refer to the same interview). He works in a big collaboration of five hundred scientists which is highly organized, with scientists coming and going to the Laboratory at scheduled times. Access time to the accelerator is precious and expensive. Government grants from the Department of Energy are vital to this work. He has published about twenty-five papers with the collaboration in the last five years. “Sometimes my name appears on a paper that I have very little to do with and sometimes I publish papers that others have very little to do with.” They appear almost always in *Physical Review Letters* and *Physical Review D*. “Publications only really count in this field if they appear in one of these two journals. Those are the only ones we publish in.”

The way that the collaboration does its work and produces a paper is also very organized. “We have a big hierarchy. We have lots of hierarchy... People submit ideas in a meeting and discuss it. If you get the blessing of the group to proceed, you get some students and work begins. After some work is done, you go to the meetings and show your progress. Then in the hierarchy there are people who can approve if you can go further. They are the ones that can help you get the needed resources. Upon completion, you write a paper with the blessing of the group that you are in. First you write up a note on the analysis with all the details in it. Then it gets submitted to the collaboration which appoints its own editorial board. This board is made

up of about four of your colleagues inside the collaboration, but outside your particular physics group. Everyone goes over it. They make suggestions, and after several iterations, the paper is submitted to the style board for final review. At this point, with a half of the field being in my collaboration, all those people have already seen it before its gets sent to the publisher.”

These big experiments have no trouble getting published. Timeliness is important, but with all the internal vetting, the work proceeds through peer review very quickly. “You want them to publish it reasonably quickly because sometimes they are written by students, as a thesis, and they are ready to leave. If you have to wait five months for a reviewer’s comments, the students could be gone.” *Physical Review Letters* can get it out in two to three months which is satisfactory.

Dr. Baden used to read electronic preprint archives, but lately, he has had trouble finding time. He finds them easy to read and search. He has never submitted a publication to the servers individually, but his collaboration does. “In my field the Los Alamos e-print servers are pretty important. Lots of people are reading them and using them.” When I asked if his community would look upon the servers as a place to establish priority, he responded, “I don’t know. Mostly what you see there are theoretical physics papers, so anybody who has some cockamamie idea can publish it. You can look and sometimes you see some reputable people whose work you want to read...New theory for this and that...Theorists might post manuscripts individually, but we’re not allowed to do that kind of stuff. I think in our groups you get it published first, and then you put it in the archives.” In these large collaborations there are rules about when something can be released to the public, and it’s the review board that decides when and how it will be published. Everything has to go through the conveners of the groups, the heads of the committees and the leaders of the collaboration. In his opinion, editors and reviewers do not have time to read all the articles appearing on the servers. They do not refer to the e-prints in reviewing a manuscript. “They’re not official things. I don’t think they should be cited.”

Dr. Baden did not have a clear understanding of the process by which authors sign over copyright to their work when they submit a manuscript for publication. Obviously, he has been spared any worry over these kinds of details, even though he has published many articles. That kind of busy work is probably taken care of by the internal publication committee or others who

are more concerned with getting the work ready for submission.

### ***Dr. James Drake***

Dr. Jim Drake, a full professor, is a theoretical plasma physicist. Plasma physics is the second or third largest division in physics. When I asked him how his work coincides with experimentalists in his field, he explained that the relationship is very tight. For example, he interprets experiments. He works with experimentalists in plasma physics to plan what to measure and writes papers jointly with experimentalists, on occasion. Usually when something unexpected happens during an experiment, the theoretician would step in to try and explain the phenomenon. And conversely, a theoretician might come up with an idea that is then tested by the experimentalist.

He has never written a patent on his work, so he is under no publication constraints. He explained that experimentalists in plasma physics would be more likely to need to write patents on a discovery. He collaborates with people all over the country and abroad in doing his work. In the past five years he has published forty papers, most often jointly, either with his students or with collaborators around the world. He seeks publication in *Physical Review Letters*, *Geophysical Research Letters*, and *Physics of Plasmas* or the *Journal of Geophysical Research*. He finds that because of the prestige and timeliness of publication, it is most difficult to get published in *Physical Review Letters*. He is most concerned to get papers published quickly. Plasma physics covers many areas and is spread broadly--from fusion work in the laboratory to space physics. Dr. Drake's work spans many areas, and he is often asked to review papers.

“The thing that has changed in this whole process of submission of papers and refereeing is doing it through e-mail. Years ago, we used to spend thousands of dollars sending preprints to everybody around the country-- to colleagues. Now the process is speeded up. We submit papers electronically, and the editors ask you by e-mail whether you will review a paper... However, most of the journals still send the papers to me through the mail...That's still archaic, but e-mail is just taking over the world.” (Dr. James Drake, personal communication, December 17, 1998. All the quotes in the following section refer to his comments during the interview) He writes his papers in LaTeX.

He once served on the publications committee of the Division of Plasma Physics. It was at the time when Ginsparg's e-print servers were in the news, so he experimented with the e-print archives for plasma physics. "I tried logging-on to see some papers. At the time, the process was very ponderous. It wasn't friendly at all, and the way of submitting was just a pain in the neck. They didn't have the format down. You had to do it in a particular format, and I wasn't at all impressed. It's just not convenient. They tried to set up a place for plasma physics, but it basically went nowhere, and I don't know anybody who uses it." I suggested that some other physicists found them very useful possibly because in fields with hot competition, they were the quickest way to establish priority for an idea. He quickly retorted that there is a lot of 'hot competition' and concern for timely dissemination of papers in plasma physics as well, but they use a method that completely circumvents the e-print archives.

Dr. Drake uses his personal web page to "publish" his most current work.<sup>10</sup> He puts all his new papers on the web site, both those that have been accepted for publication as well as those that have been submitted. He alerts others who might be interested in it. "It's like your own e-print server. You just give people your web site address...You know who's really doing the good work in your field, so you just connect to their website or ftp site." When I mentioned the experimental e-print server set up by the APS which is attempting to find out if people in fields like plasma physics might have an interest in using the site to disseminate information, he commented; "To be honest, my impression, at least in my field, is that this e-print server thing is fading."

The personal website is meeting his need for rapid dissemination. "If I go to a meeting, I know that there are some people that really need to see my work, so I give them my paper, or, I alert those people about my paper and the URL address. That avoids being scooped because immediately, it starts getting passed around, and pretty soon everybody knows about it." He acknowledged that publishers do not want manuscripts that have been too widely disseminated before they appear in the journal. "They are going to lose this battle. Web dissemination really facilitates getting the word out, and people are going to continue to do it....They can't reject the

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<sup>10</sup>Available: <http://www.glue.umd.edu/~drake>

best papers...”

He does use the electronic subscription to *Physical Review Letters*, having dropped the hard copy subscription. He doesn't have much time to review the table of contents systematically, however, and he would prefer to find a reminder in his e-mail every week about any new plasma papers. Electronic communication is clearly having an impact in his way of doing business, but the e-print archives are not as important as other use of the electronic medium.

### ***Dr. Victor Yakovenko***

Dr. Victor Yakovenko's field is theoretical condensed matter. He is an assistant professor of physics and has been at UMD for five years. He has had grants from the National Science Foundation, Packard Foundation and the Sloan Foundation. His work does not involve patents, and he is not under any publication constraints from these grants. He works with collaborators at the University of Maryland, Naval Research Laboratory, California, Germany and Japan. He seeks publication most often in *Physical Review Letters* and *Physical Review B* because they are the most prestigious journals in his field, both with a large circulation. According to Dr. Yakovenko, because so many people try to get published in *Physical Review Letters*, it is harder to get published there. They also use two reviewers rather than one. “To get published in *Letters* is a sign of recognition, but the selection criteria are very tough. They are also arbitrary. They have three criteria that must be satisfied for acceptance, and the referees decide. The first one is validity, so it must be correct, but this is the least important. Nobody can really check validity. The second criteria is that it must be original work. The third one is that it should be of interest to a broad audience. That is very vague and arbitrary.” (Dr. Victor Yakovenko, personal communication, December 14, 1998. All the quotes in the following section refer to his comments during the interview)

In the past, if he needed to get something published very quickly he submitted the work to a Russian journal called *JETP Letters*, that would get it out in two months in English. The journal would establish the date of official publication. He now uses the e-print servers, but he acknowledged that the work might not be completely recognized as official by everyone until it

gets published in a peer reviewed journal. “People normally refer to the official publication from the journals.” Occasionally, he has been frustrated by the lag time to publication. Sometimes his papers wait from six months to a year before they get published. “Now *Physical Review* accepts references to the e-print number, so people cite them by their number. Some people nowadays have all their publications listed as e-prints because they do not take the time to go back and submit the updated journal reference, once the manuscript is accepted for publication.”

“I don’t read e-prints because I don’t have time. I would really like to. When I was on sabbatical, I actually read them. The number of submissions has grown tremendously since 1992, so it’s too much material...There should be some sort of a filter or a better index to search the database to narrow down the results. The filtering tools are not developed enough. The keywords are not very helpful. Any kind of classification is behind or outdated. By the time they establish “Quantum Hall Effect,” for example, it is already a huge, established field, and we want to work in some emergent field...some new field. “Quantum Hall Effect” is already done, basically...I usually go to the e-print archives when I have heard, say at a conference, of a particular paper with a specific Condmat number. Or I search by an author’s name if I learn about some new work.”

Dr. Yakovenko has a personal web page, where he lists some of his recent publications, but he prefers to submit his manuscripts to the e-print archives where they have the potential to reach a wider audience. Over the past five years, he has submitted more than twenty-five papers to the Cond-Mat archive at Los Alamos. He has found that he gets quite a bit of feedback from readers. It is somewhat of a double-edged blessing because responses take additional time. Some readers will refer him to additional papers that they want him to read, so it can be frustrating. He usually submits manuscripts simultaneously to the e-print archives and to the journal. When he submits papers to Cond-Mat, he formats in one way, with two columns and the figures inside the text with a small font. It has the look and feel of the way it would look in a journal. But when he submits to *Physical Review*, he has to reformat it. It has to be double-spaced with figures at the end, and with a large font to make it easier for the reviewers. So he usually submits them as separate files. Dr. Yakovenko is very knowledgeable about computers. He spent quite a bit of time explaining the way TeX, LateX, and RevteX have developed. TeX

automatically calculates the equation numbers as you're working in the document. If you insert an equation, all the math and references are automatically updated for you. The source file is then compiled with the device independent file (dvi) which is converted to post script for printing. Unix networked computers can read the postscript files, but you need the portable document format (pdf), which is compressed postscript, in order to read and view it on most personal computers.

When I asked him if he felt that submission to an e-print archive established priority to an idea, his answer reflected the ambiguity of the current situation. "Well, it's not very clear right now. Who determines priority? In my field, which does not involve patents, it's more like public opinion that decides. The community develops it. The people who write in my field decide. So basically, yes, I think that Cond-Mat does establish priority. For example, speakers at a conference will mention their paper on the Cond-Mat archive and announce their results. People do cite this, and in private conversations, they will ask if you have seen a recent paper on the archive. So, priority is really established by the opinion of your community. I think submission to the archives does establish priority because it has a submission date and every revision is tracked very carefully." He went on to say, "People in my field who don't use the archives are left out of the loop." It seemed to me, that this was the first time that Dr. Yakovenko was addressing some of the implications of these e-print archives. His responses became more definitive as the interview progressed, almost as if he were in the process of convincing himself that the archives are supplanting some of the traditional roles held by formal journal publication.

### ***Dr. John Cerne***

Dr. John Cerne's field is experimental condensed matter. He is a post-doc, working on research with no teaching responsibilities. He works with high temperature superconductors investigating many new materials. There are so many theories coming out about these new materials, that experimentalists are hard pressed to try and keep up with putting them all to the test. He is not under any publication constraints, working under an NSF grant. His laboratory collaborates with others in Canada and elsewhere in the United States in order to get samples or films from places like Bell Labs and Princeton. He has published about twenty articles in the

past five years. He submits to *Physical Review B*, *Applied Physics Letters*, and *Physical Review Letters* (PRL). He uses the Inspec database to do literature searches, typically starting with keywords or subject matter, and the journal that he takes time to read each week is *Science*. Timeliness is pretty important in his field. Clearly, if he is working on a new result that a lot of people have been trying to get, then speed is everything. Often he submits to *Physical Review B* because it can be just as fast as *PRL*. “With a less stringent review procedure (only one reviewer as opposed to two), and no space constraints, it is pretty quick.” (J.Cerne, personal communication, January 21, 1999. All quotes in this section refer to this interview.)

Dr. Cerne occasionally reads the e-print archives, but he was quick to comment that it was his boss who usually uses them the most. “He keeps ahead of what’s new for the rest of us.” His boss reads both theoretical and experimental papers on the Los Alamos condensed matter archives. “I don’t look at it so much because I’m trying to do measurements.” He has never submitted a paper to the e-print archives although others in his group have, after being encouraged by their boss. The instigator is their boss, who claims to be a minimalist when it comes to computers, so he gets the young guys to submit them. Dr. Cerne is comfortable working with TeX and electronic submission, although he sends his figures in hard copy when submitting articles to journals.

When I asked why theoretical physicists used the archives more, he responded; “I think theorists publish more. For them to write a paper doesn’t take nearly as much time as it does for an experimentalist. They can do a calculation on a specific area, and they can start right away. Whereas we have to set up the experiment. It takes us a long time to get one measurement done. They have more papers and want to get them out. We have to make absolutely sure that our measurements are right.” One real motivation for not using the Los Alamos archives is because he doesn’t want to publish anything until he is sure that it is correct. His real goal is to get it published in the official journal. He also acknowledged that he has not submitted manuscripts to the archives because no one around him has actually shown him how to do it. “When we submit something new, we do not want anybody to know about it until it has been accepted. We have had problems before when we’ve made a new measurement and submitted it. Other people doing the same measurement submitted the same results at the same time. They had less trouble

with the referees, but since it was a friendly competition, and the receipt date was stamped on our paper, we argued about it with the editors. Fortunately, they were willing to let us get published together.”

“The archives are nice to let people know what you’re working on. Maybe with this next paper, we’ll put it on the archives this time...I give out hard copy preprints but I don’t want to distribute them in massive numbers. I want to keep control over my data until it’s been formally accepted.” In talking to Dr. Cerne, I soon realized that he had not thought too much about using the archives. He was not aware of the possibility of simultaneous submission to both the archives and the formal publisher. As we talked, he seemed receptive to learning more about them. Right now his major concern is finding a job, and he is focused on having enough publications in the formal journals rather than experimenting with the archives.

### ***Mr. David Steinhauer***

Mr. David Steinhauer is a research graduate assistant in the Center for Superconductivity, working in solid state and near-field microwave microscopy (D.Steinhauer, personal communication, January 21, 1999). The Center has a large grant from the NSF and they are seeking funding from industry because of the patent implications of some of their work. He is currently receiving royalties for some of the inventions in the lab. He has published nine articles and submits with his group most frequently to *Applied Physics Letters*, *Review of Scientific Instrumentation* or *Applied Superconductivity*. Mr. Steinhauer has submitted two papers to the Condmat archives at the behest of his boss. He does not have time to read the archives, relying on his boss to keep current with the literature. He explained the difficulty he had in manipulating the files during his first attempt. Since his graphic files were done in Powerpoint, he had to convert them to Postscript and get it all in TeX. It was a complicated effort. When I questioned whether his group might be wary of using the e-print servers where patentable ideas might be scooped, he responded that it was not a problem. They usually submit in *Applied Physical Letters* which is limited to three or four pages. There would not be enough detail in a presentation of this kind to allow competitors to copy or imitate their work.

David’s group presents quite an anomaly vis a vis the e-print archive. I communicated

with one full professor that publishes in this group, who told me that he did not use the archives. “I don’t use the preprint servers. I don’t have time to use them, and don’t feel like I need to see someones’ latest result as soon as possible.” (Anonymous personal communication, December 3, 1998) “An additional factor is that I like to think things through for myself and tend to use the literature more as reference matter rather than as inspiration. Furthermore, there is just too much junk being put out as it is, especially via the web and e-mail. If I stick with a journal like *Applied Physics Letters* or *Nature*, I know what kind of quality to expect and I waste a lot less time sifting through junk....I do a lot of applied research and this is a real show stopper. If you put it on the web, there really is no copyright protection and you’ve just given up any patent rights. Until you’ve got some protection on your intellectual property you shouldn’t be using the web or e-mail to broadcast.”

A few days later I was surprised to find several of this professor’s papers posted on the Condmat e-print server! Later I learned that another full professor in the group had initiated the process of submitting them. Here we have two different attitudes about the servers in the same community. This might be explained by a lack of communication or a situation that is still in flux. This could point to individual styles or a variety of views on emerging computer technologies.

### ***Main Themes and Issues***

One fact that emerges from these interviews is that the actual usage of the e-print archives is quite varied among physicists. In addition to cross disciplinary differences, there are differences among subfields in physics. I started this project assuming that most physicists were computer whizzes and that most would be using the archives. Instead, the picture is more complicated. Particle physicists and condensed matter physicists are the two main subfields that use them the most. Theoreticians, especially, gravitate to the archives because the medium supports this wonderful way of communicating ideas quickly and fluidly, almost replicating a conversation. Experimentalists are less likely to use the archives, and it may be because they do not want to wade through unrefereed papers. “But recognizing poor science may be easier in the theoretical fields that spawned the first bulletin boards than in experimental fields, where a reviewer has to evaluate experimental design and statistics as well as mathematical reasoning”

(Taubes, 1993, p. 1248). Mr. Cerne's unwavering commitment to making sure his measurements were correct points to this need for the formal review process among experimentalists. David Steinhauer's experimental group includes one mid-level career scientist who refuses to bother with the e-print archives. His affirmation of the importance of journal peer review to provide the quality control and to simply save him time from reading through a huge pile of raw, unfiltered papers is interesting. Comments from many of the theoreticians suggest that they care less about the need for peer review.

It is also clear that even though it is the older researchers who might have the time and inclination to read what is appearing on the archives, they consistently turn over to their graduate students the job of navigating the technical problems. At the same time, these interviews indicate that mid-level and older scientists are consulting the e-print archives more than the younger scientists. It is alarming that the younger scientists do not feel the need to read their journals.

Another issue that emerges is the appeal of the hyperlinks for the particle physicist community on the e-print archives. The ease of having the equivalent of a science citation index included in the e-print server right on the researcher's desk-top is very appealing. There is no question that the ability to quickly review who and how your research paper is being cited can be not only flattering but fruitful. Could this technology possibly open up new research specialties or relationships or lead to a "thickening" of communication as the social circle widens (Chubin, 1976)?

In the next chapter, we will see how chemists differ in distributing their research. Hopefully, the variability will help explain why some researchers are motivated to use the archives, while others do not. An effort has been made to focus on physical chemists to test the proposition that the subject content of a subfield might have some impact on attitudes about the e-print servers.