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# The Modern U.S. High School Astronomy Course, Its Status and Makeup II: Additional Results

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## Abstract

A postal survey of high school astronomy teachers strongly confirms many results of an earlier electronic survey. Additional and new results include a measure of the level of inquiry (more structured inquiry and teacher-led) in the classroom as well as data showing that more emphasis is given to traditional topics than to contemporary astronomy research. The majority of students taking astronomy are college-bound, which offers support for the idea that astronomy might be considered as meeting college admissions requirements, even though it is not a laboratory or "core" science course. More usage of planetarium software is found than previously suspected, and more definitive usage rates for fixed and portable planetariums are found. By combining the two surveys' results we obtain an even clearer picture of the current nature of high school astronomy courses.

## 1. INTRODUCTION

Results from a nationwide survey of high school astronomy teachers (hereinafter called the Spring survey, because it was done in the Spring of 2007, electronically via the Web and e-mail) was previously reported (Krumenaker 2009, 2008). An overall description of the courses, schools with the courses, the teachers and students, course materials used, etc., was given, and some of the effects of the No Child Left Behind Act on astronomy courses were indicated. The number of possible high school astronomy teachers estimated before the Spring survey was between 2500 and 3500. This small size brings the chance to get population parameters (i.e., information from the entire population of astronomy teachers) instead of sample statistics. Therefore, to that end, a survey was postal mailed to more than 2100 teachers in the Fall of 2007 as opposed to soliciting response through emails direct to the teacher or through announcements on mailing lists/listserves as in the Spring survey. Participants were selected mostly but not exclusively from the National Registry of Teachers (NRT) database maintained by the National Science Teachers Association. Other names were from those gathered during the first survey but who did not have working e-mail addresses. No name on the Spring survey, whether a respondent or nonresponder, was used on the second survey, henceforth called the Fall survey.

Unlike the Spring survey, which was conducted via a webpage or with a Word document, the Fall survey contained a six page printed survey with a preprinted no-stamp-needed return envelope and included some incentives that could be earned just for responding to the survey as a means for increasing the response rate. About a month later, a postcard reminder was mailed out as well. Both survey and postcard mailings included directions to a webpage where the survey could be answered electronically if the teacher so chose. A total of 127 surveys was returned, a 6% rate of return after bounced responses were removed from the pool. Useful surveys numbered 115. About 64% came back via the postal mail and e-mail. The rest were answered via the webpage.

This new survey was very similar but not quite identical to the Spring survey one. Several questions were dropped as they had reached their apparent limit of productivity. Using our new knowledge, nine questions out of the original 55 were revised in small ways. For example, the Spring survey uncovered the expanding use of planetarium software as a replacement for fixed or portable planetariums, so the replacement question had all the original choices plus a new one for planetarium software. Finally, we added three new questions on the post-high-school plans for students, the level of modern content in the course, and the level of inquiry in the instruction. The Fall survey had 51 questions in total, with 29 questions plus basic contact information, identical to the Spring survey.

In addition to providing some new results, another purpose for the survey arose after it was completed. An anonymous reviewer to the first survey article raised the concern that the Spring survey could perhaps be skewed because of its electronic response nature and that the results not be generalizable to the whole population of high school astronomy teachers. Since the Spring survey results were compared to the pioneering results that Sadler (1992) made more than two decades ago, which were done by postal mail, could there be some differences that also make the comparison more of an apples and oranges, rather than fruit, situation? This Fall survey could inform both questions and be a check and validator of the information of the first survey.

There appeared to be some small differences with the two survey populations. The Fall survey teachers appear to have longer time in service, by about 1–2 years. The percentage of terminal Bachelor's degrees is twice that of the Spring survey (27% versus 13%) though more teachers still have graduate degrees than just terminal Bachelor's. Still, the teachers averaged about the same amount of astronomy training (i.e., 1–2 courses in college). Even fewer teachers were full time astronomy (5% versus 15% in the Spring) but the overall number is still small. Additionally, the male/female ratio is 79:21 here versus 67:33 in the spring survey. The Fall result falls just outside a one standard deviation (s.d.) of variance from the Spring survey results (the standard deviation was 10%, based on variance through the ten weekly spreadsheets of data of the Spring survey). Despite these differences, $t$ tests indicate no significant statistical differences, with $p$ values ranging generally from 0.20 to 0.50.

In the student population demographics, we noted that there were twice as many Hispanic students as in the Spring demographics but the makeup of the classes that are high or "normal" minorities are virtually the same in both surveys. The demographics of astronomy classes still more closely represent national demographics than almost any other science course, with Hispanics and others slightly depressed.

The Fall survey is much more rural and less urban than the Spring survey. We believe that this is due to the high percentage of schools coming from the NRT list, which has rural and urban values demonstrably different from the national values from The National Center for Educational Statistics (NCES 2005), which has values of urban 33% and rural 23%. The average sizes of schools in the Fall are slightly smaller (1361 versus 1581) but both are within the standard deviations of the Spring survey values. A $t$-test $p$ value is 0.39. This apparent shrinking school size is more likely again to be a consequence of using the NRT list so much in the Fall; its average school sizes are smaller than the national averages. In the Spring survey, there were nearly twice as many schools reporting decreasing enrollments as increasing, but the Fall schools' tallies indicate a virtual statistical dead heat between increasing, steady, and decreasing.

## 2. SIMILARITIES AND VALIDITIES

With more than half of the questions on each survey identical, the only difference between them becomes the methods of soliciting and receiving answers. The Spring responses were 85% by webpage form and 15% typed-in protected Word documents. The Fall survey responses were 64% handwritten forms by return postal mail and the remainder as filled-in webpage forms.

One major statistical issue could have been the smaller number of Fall responses, which was essentially 50% of the Spring survey response number. Yet, virtually every analysis in the Fall survey came up with answers that are nearly identical to, or statistically tested as not significantly different from, or at least trend similarly to the same answers on the first survey. Table 1 lists many of the in-common question results.

**Table 1. Common Survey Analyses in Spring and Fall Surveys**

| Analysis | Fall survey result | Spring survey result |
|---|---|---|
| Sections per instructor, one, two, and three sections | 51%, 26%, 13% | 55%, 25%, 14% |
| Teachers per school | 1.32 | 1.31 |
| Male/female students | 53:47 | 53:47 |
| White/Afr-Am/Asian/Hisp | 71%, 9%, 3%, 16% | 77%, 8%, 4%, 8% |
| Proportion of teachers with advanced degrees | 73% | 70% |
| Average number of astro courses taken, undergrad/grad; | 1.66/1.24 | 1.89/1.96 |
| if ≥1 course taken | 2.38/2.12 | 2.65/3.50 |
| Public: private schools ratio | 85:15 | 87:13 |
| AYP proportions: Pass, N.I., Fail | 73%, 24%, 3% | 77%, 20%, 3% |
| Top ten survey responding states in top 10 Population and NRT | Pop.: 8 NRT: 8 | Pop.: 7 NRT: 6 |
| Top four purposes for a course: appreciation, mental discipline, multidisciplinary, literacy | 44%, 18%, 19%, 7% | 38%, 17%, 16%, 10% |
| Block, period, other scheduling | 35%, 62%, 3% | 41%, 51%, 8% |
| Year-long, semester-long, other | 37%, 52%, 11% | 37%, 55%, 7% |
| Section sizes: public, private ($t$-test $p$ values$=0.50, 0.45$) | 21.4, s.d.=8.0; 15.1, s.d.=6.4 | 22.7, s.d.=6.9; 16.6, s.d.=6.8 |
| Taken by grades 11–12, 9–10, 10–11 or 10–12, or all grades | 76%, 5%, 15%, 4% | 75%, 4%, 16%, 5% |
| High minority, minority, representative, low minority schools | 18%, 8%, 25%, 50% | 13%, 7%, 29%, 52% |
| Budget | \$200–300, 2nd peak at \$500 | \$200–500 |
| NCLB influences (none, positive, negative) | 66%, 9%, 25% | 60%, 7%, 33% |
| Teachers degree areas: BA science; education, other | 70%, 18%, 12% | 65%, 16%, 19% |
| MA science, education, other | 32%, 66%, 2% | 36%, 57%, 7% |

This abundance of similarities abounds even in the open-ended qualitative questions. For example, in both surveys, we asked teachers how they keep up with astronomy. A number of answer choices with checkboxes were given and teachers could choose any or all answer selections they wanted. Extra space was available to write other details, such as which books or websites they would recommend. Despite the fact that the selections were a bit different on the two surveys, both surveys picked the same three top items: NASA webpages, non-NASA websites, and books. The Spring survey's second highest item was actually science and astronomy magazines, notably *Sky & Telescope* and *Astronomy* magazines. Because we were more interested in gathering details on books, webpages, and conferences in the Fall survey, the magazines were not a choice this time. Nevertheless, both showed up frequently in the books detail answer area so we can most likely agree that the four items are still the top choices. But workshops and conferences, NASA or others, as ways to keep up suffered significant drops in proportion between Spring and Fall.

It appears that the methods of solicitation and the forms of responses did not appreciatively affect the answers received and their resultant conclusions as discussed in the Spring survey article. This also negates the proposed problem that the electronic survey was somehow generating different responses than the postal survey of Sadler (1992). The similarity of the answers to the overlapping questions in the two surveys suggests that their data can be combined.

The next two sections discuss the results of the new questions, one interesting difference between the two surveys, and some generalizations that can be made when the results of the two surveys are combined.

## 3. NEW RESULTS FROM THE FALL SURVEY

A. The first of the three new survey questions comes out of our research question about the students who take the course. In both surveys, the student population was examined for gender, racial/ethnic demographics, and ages (grades) of the students who take the course. Now we asked the teacher to check one answer to the following statement:

My students are college bound.

( ) Yes (67–100%) ( ) Mixed (34–66%) ( ) No (0–33%)

"Yes" was reported 61% of the time, 35% said "Mixed," and 4% checked "No." So in addition to the students being ethnically/racially generally representative of their schools and the national demographics, only slightly more male than female and mostly upperclassman, they are far more often college bound than not.

Incidentally, if the Mixed numbers (essentially all those classes near 50% college bound and not) are split between the Yes and No tallies, the numbers become 78.5% college bound and 21.5% not, which is almost precisely the high school graduation rate of 74.3%, the latest available when the survey was done (National High School Center 2006; NCES 2007).

Astronomy is most often a capstone course in high schools and is taken after any required traditional sciences. The fact that college-bound students *choose* to take astronomy in numbers that clearly match national graduation proportions gives support to the idea that astronomy can be considered college admission worthy.

B. In discussing the course, teachers had been asked about course content, whether solar system only, stellar only, both, or other; the purpose the course supports; curriculum materials, such as textbook, budget, planetarium, and telescope usage; and more. In the Fall survey, two more instructional questions were asked, one was the following:

Define a "traditional astronomy class" as one that teaches moon phases, causes of seasons, inventory of the solar system, history of astronomy, basic cosmology, naked eye astronomy, i.e., "teaches what and back when." A "contemporary astronomy class" would be one that teaches about current topics, such as cosmology and dark matter, exoplanets and current planetary missions, observational experiences. and a "teach how and now" class. Your general class could be described as one of the following:

1) All of mostly (80–100%) traditional.
2) Largely traditional (60–79%).
3) Evenly split (40–59%).
4) Largely contemporary (20–39% traditional).
5) All or mostly contemporary (0–19% traditional).

This question comes from the debate between how much traditional and how much contemporary astronomy should be taught (largely at the college level) and is espoused in a 2002 article by Pasachoff (2002), where more than two dozen other references in this controversy can be found. The results are in Table 2.

**Table 2. Content Timeframes**

| Traditional/contemporary mix | Percentage of teacher responses (%) |
|---|---|
| 1) All of mostly (80–100%) traditional | 17 |
| 2) Largely traditional (60–79%) | 42 |
| 3) Evenly split (40–59%) | 46 |
| 4) Largely contemporary (20–39% traditional) | 5 |
| 5) All or mostly contemporary (0–19% traditional) | 5 |

Based on this simple scale, high school teachers are still leaning more traditional than contemporary though some have designed courses that are wholly "modern."

C. The final new question was the following:

In the following continuum, my classroom teaching would be (choose one):

1) Teacher-led with verification laboratories/activities.
2) Structured inquiry (teacher leads and specifies procedures but students use some critical thinking skills).
3) Guided inquiry (teacher sets problem but students work out procedures).
4) Open, student-led inquiry.

These selections are based on an article by Bonnstetter (1998) and a host of webpages that unfortunately are no longer apparently available, such as www.convertingcookbooks.missouri.edu and www.learnnc.org. Overall, the four responses had proportions of 36%, 53%, 10%, and 1%, respectively. Classes are still strongly teacher-led but with more and more including some form of inquiry teaching.

We can therefore claim that the high school astronomy class, especially since it is not usually a standardized course (in terms of state standards or end of course testing), is a less traditional (but not particularly contemporary) content area or classroom teaching style.

D. Both surveys investigated planetarium usage; below is the Fall survey question.

What access to planetariums do you have? (choose one)
( ) Our school has a fixed planetarium in it. We visit it _______times per course.
( ) We regularly use a fixed planetarium elsewhere and visit it _____ times per course.
( ) We own a portable planetarium at this school and I use it _____times per course
( ) We borrow a portable planetarium and use it _____times per course.
( ) We use "planetarium" or sky software as a planetarium substitute.
( ) We use no planetarium of any kind.

The larger Spring survey did not include an answer choice of "using planetarium software." This information was deduced out of a teacher's other comments. In the Spring survey, we estimated that planetarium software usage was about equal to that of portables, that is, about 3–4% of the schools each.

In the Fall survey, we explicitly gave them the answer choice about planetarium software. The Fall survey came up with 5% own portables, which is consistent but 38% using planetarium software! It is unlikely that any marketing effort by any company could have caused such a dramatic shift in 6 months or less.

Additionally, the percentage of schools having or borrowing the use of a fixed dome dropped, from 24–26% to 15% each. Our earlier Spring numbers were useful and accurate in determining the number of fixed planetariums we should expect, nationwide, a number that matched estimates using planetarium directories. A chi-square test yields a $p$ value $<0.001$ so there appears to be a true difference in the distribution of different planetarium types within the two populations.

Yet, we think the Fall values are an anomaly, that the percentage of software is the other extreme from some undetermined mean value. It is also possible that by specifically including this answer, a selection effect was introduced. A weighted average would yield about 15% for planetarium software which seems more realistic.

Usage information for all four main kinds of planetaria were estimated from teacher comments in the Spring survey. When a planetarium, fixed or portable, was owned by that school, it was used for 1–3 weeks of time, when borrowed or visited offsite it was estimated for just 1–3 visits or days. The Fall survey obtained much better, yet still consistent, usage rates for planetariums by explicitly asking for the data. The average when a fixed dome was at the school full time is 14 days, when using a fixed dome elsewhere, 1.6 days or visits, for owned portables 6.7 days, and when borrowed 1.25 days.

## 4. GENERALIZED RESULTS TO ADD TO THE SPRING SURVEY SUMMARY

The following new conclusions, generalizations, or revisions are now added to the results in the Spring survey article to complete the overview picture.

## 4.1. Students

More students appear to be college bound than high school terminating. About two-thirds, at least, plan to go to college, and it may be possible to argue that high school astronomy students are college bound at the national high school graduation rate of about three-quarters.

This information should give support to the idea that astronomy is an acceptable course for college bound students and given credence as acceptable college admission material. As a capstone we have already noted numerous comments that it combines material and skills learned in the mainstream science courses. If it were consistently laboratory oriented or considered an acceptable physics substitute, it should not be such a difficulty for colleges to accept in a student's record.

## 4.2. Courses

In addition to being mostly upper-class elective courses that usually teach both solar and stellar systems in one semester, high school astronomy courses still teach more traditional topics than contemporary topics, though they have moved away from traditional teacher-centered courses. They are also more inquiry based, on average, with most in the guided inquiry to structured inquiry type of course.

Enrollment maybe a bit less decreasing than suspected but it still is not increasing nor steady over all the high school astronomy courses.

## 4.3. Facilities, Materials, and Operations

Planetariums are used in most courses but the type and proportion are variable. We believe that planetarium software is a rapidly growing form of planetarium usage. We believe it is used in around 15% of all courses though it could have grown beyond this amount by the time this article was written. Fixed domes are found at the school itself probably between 20 and 25% of the time. Schools owning a fixed or a portable dome use them an average of 14 days (3 school weeks) whereas those schools that borrow a portable use it for a little more than an average of a day, slightly less than schools that use a fixed planetarium dome elsewhere averaging about 1.6 days per course.

Table 3 lists the rankings and percentages of what teachers considered their top wish or need. Because we believe we can combine the results of the two surveys, we can therefore state that, overall, the top problems or wishes of teachers are the needs for more time, better curricular materials and technology, and fewer scheduling problems, where teacher comments indicated their concern on the placing of unprepared students into the classes with prepared ones. Funding is a high concern, which is reflected in the technology desires, and "more supplies," which is reflected in curricular complaints. Still, many teachers claim to have no problems or wishes to fulfill.

**Table 3. Teachers Wishes or Problems Ranking Lists**[a]

| Wish or problem | Fall survey | Spring survey |
|---|---|---|
| Time | 1 | 1 |
| Space | 8 | 7 |
| None | 4 | 4 |
| Funding | 2t | 6 |
| Other[b] | 3 | 2 |
| Attitudes | 5 | 3 |
| Supplies | 2t | 8 |
| Professional Development | 7 | ··· |
| Student Prep | 6 | 5 |

[a]"t" in the rankings indicates a tie and "..." indicates "not ranked."
[b]Included Professional Development in the Spring survey.

## 4.4. Teachers

More teachers teach Earth science or physics than any other course besides astronomy. Physical science, other courses (mainly meteorology, environmental science, and more), and chemistry make up most of the rest. Despite their high number in terms of Bachelor degree majors, biology teachers do not teach as much astronomy as the others above.

Longevity in teaching the course tends to average about 10 years, plus or minus 1 year. For those who no longer teach it, the longevity is about 2 years less, also plus or minus 1 year.

The number of full-time astronomy teachers is more likely 10% more than what earlier estimates would believe.

The number of teachers working alone in astronomy in their school may be a little higher, closer to three-quarters rather than two-thirds. Still, they are quite alone.

The two-thirds/one-third male to female teacher ratio may be a bit high; it may be more like 70–30. The conclusions on improvement in the gender gap are unchanged.

## 4.5. Professional Development

Keeping up with astronomy education is not as high a priority as keeping up with content. A large percentage, more than a quarter, do not bother to keep up with pedagogical concerns.

Of those that do, the primary means are NASA web resources and educational workshops or conferences. Science/science education organizations newsletters and magazines make up the rest of the professional development source materials. NSTA, its conferences, its magazine *The Science Teacher*, and NASA conferences at NSTA meetings are the only other resources mentioned many times. At the college level, certain large astronomy education programs, such as Hands-On Universe or RBSE, do not get much mention. Neither does this periodical, *Astronomy Education Review*. Many resources were mentioned but never more than once.

# 5. SPECULATIONS ON METHODOLOGIES AND SUBGROUPS

Even though all our data in both surveys seem to indicate a rather homogenous population, there were some indications that the people who would tend to answer in one way, say, on a paper survey as opposed to an electronic one, may have some subtle differences after all. In the Fall survey, we noticed distinctly different results in the teaching style (inquiry) question between paper responders and web responders. 6% of the paper responders stated guided inquiry and 44% of them responded with teacher-led. But the web responders responded with 18 and 23%. The numbers are small and not statistically different when checked with a $z$-test of proportions ($p > 0.25$) yet it is suspicious.

We noted similar issues with our tallies of the teachers' attitudes toward the future of high school astronomy for the nation. Though like the Spring survey, with a rough balance just above mixed or neutral opinions, those who did the paper survey had smaller percentages of optimistic and somewhat optimistic than those who answered on the web, and more pessimistic and somewhat pessimistic votes. Is there something in the situation of those who do mailed surveys versus electronic surveys that gives a slightly, if not statistically, different viewpoint?

The number of male teachers answering the survey was 85% for paper responders and 70% for web. A higher percentage of private school responders chose to answer on the web than via paper. In the tallies for enrollment trends, the paper responders had decreasing enrollment while the Web responders had increasing enrollment.

Of course this could also be the consequence of small survey numbers in the Fall survey statistics. We did not do such an analysis of Web responders versus Word file responders in the Spring survey. Still, this makes a word of caution needed for future survey workers. A large enough sample may get you the essential truth regardless of what method you use to do surveys but reliance on one type could cause some skewing of the results if response numbers are not large; Tuckman (1999) suggests at least 10% of a small population—overall these surveys have done that. Doing electronic surveying is much quicker and gathers more (at least, we did) but the whole population is not yet digitally "in" and so one must consider trying other means as well (paper survey, even if expensive, and even live interviews) to be absolutely sure there are no population subset biases than the method of solicitation and response. In our case, doing surveys both electronically and via postal services did not provide much difference in results, nor much difference with an historical survey done via postal means. Of more importance is to diversify the sources of your survey participants; a reliance on one source, such as the NRT, apparently creates more skewed values.

## REFERENCES


Bonnstetter, R. 1998, "Inquiry: Learning from the Past with an Eye on the Future," *The Electronic Journal of Science Education,* 3, 1.

Krumenaker, L. 2008, "High School Planetariums—Results of a Survey," *Planetarian,* 37(4), 17.

Krumenaker, L. 2009, "The Modern U.S. High School Astronomy Course, Its Status and Makeup and the Effects of No Child Left Behind," *Astronomy Education Review,* 8, 1.

National High School Center 2006. "High Schools in the U.S.," http://www.betterhighschools.org/pubs/documents/USFactSheetandReferences_FINAL_080406.pdf.

NCES (National Center for Education Statistics) 2005. "Table 6. Number of Operating City, Suburban, Town, and Rural Public Elementary and secondary Schools…School year 2005–2006," http://nces.ed.gov/pubs2007/pesschools06/tables/table_6.asp.

NCES (National Center for Education Statistics) 2007. "The Average Freshman Graduation Rate for Public High Schools from the Common Core of Data: School years 2002–03 and 2003–04," http://nces.ed.gov/pubs2006/2006606rev.pdf.

Pasachoff, J. 2002. "What Should College Students Learn?" *Astronomy Education Review,* 1(1), 124.

Sadler, P. 1992, "High School Astronomy: Characteristics and Student Learning," in *Proceedings of the Workshop on Hands-On Astronomy for Education*, ed. C. Pennypacker, Singapore: World Scientific Publishing, 52–62.

Tuckman, B. 1999, *Conducting Educational Research*, 5th ed., Belmont: Wadsworth.



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The United States historically had a demand for general skills rather than specific training/apprenticeships. High school enrollment increased when schools at this level became free, laws required children to attend until a certain age, and it was believed that every American student had the opportunity to participate regardless of their ability.[citation needed].Â  The U.S. government may also propose, but cannot enforce national goals, objectives and standards, which generally lie beyond its jurisdiction. Many high schools in the United States offer a choice of vocational or college prep curriculum. A postal survey of high school astronomy teachers strongly confirms many results of an earlier electronic survey. Additional and new results include a measure of the level of inquiry (more structured inquiry and teacher-led) in the classroom as well as data showing that more emphasis is given to traditional topics than to contemporary astronomy research. The majority of students taking astronomy are college-bound, which offers support for the idea that astronomy might be considered as meeting college admissions requirements, even though it is not a laboratory or "core" science course. More usa Since high schools are rated based on test results (which can affect funding) and college admissions become critical as graduation approaches, high schools place a great deal of emphasis on academic performance. Therefore, teachers have the opportunity to teach challenging, high level courses for college-bound students who take their studies seriously. At the same time, high schools also offer a wide variety of classes for students of all abilities and interests. Because of this course variety, your high school curriculum can vary widely as well. As a teacher with a math endorsement, you might One result of efforts made by the National Science Foundation (NSF) and the Department of Education, along with the National Academy of Sciences and the American Association for the Advancement of Science, has been the development of national benchmarks and standards for science education.Â  Moreover, the interdisciplinary nature of astronomy and its natural links with technology and instrumentation position the field to contribute significantly to building a strong technical work force for the 21st century.Â  FIGURE 5.2 New York City junior high and high school students assembled in the Hall of Meteorites of the American Museum of Natural History for a live Public Broadcasting System program during the Mars Pathfinder landing in the summer of 1997. Astronomical Laboratory. Additional physics and astronomy courses (choices are different for BA and BS students). If you're earning a BS, you'll also take Calculus III and a linear algebra course.Â  Its 29 faculty members work in astronomy and in nine areas of physics, including atomic and molecular, condensed-matter, high-energy, mathematical, medical, nuclear, optical, plasma, and space physics. Departmental research garners more than $16 million per year in external support.Â  Additional resources on the UI campus include microfabrication facilities, the Iowa Advanced Technology Laboratories, and the Optical Science and Technology Center. Varied labs are devoted to plasma, medical, atomic, high-energy, and molecular physics.