

ANNUAL REPORT OF THE DEPARTMENT OF PHYSICS

17 July 1967

TO: William J. Newman, Acting Dean, CIA  
Philip E. Kubzansky, Dean, GRS

Copies to: Professors, Department of Physics

FROM: Robert S. Cohen, Chairman (on leave)

This Report serves as a record of Department activities. It is deliberately brief, because there have been several long-range memoranda written during the year in connection with the University's long-range planning report, and also in connection with the various committees which have dealt with the need and the practical possibilities of constructing a new science laboratory building to include physics. Furthermore a three-year budget proposal supplemented in some detail the ten-year projection which was prepared for the science building planning committee. In addition the summary statistics in this report may be supplemented by the NDEA and NSF applications of the last two years. Finally, the Chairman being on sabbatical leave, this is no time to write a detailed Annual Report.

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Note: The Department of Astronomy is the subject of a regular Annual Report by Professor Hawkins. Matters concerning graduate Astronomy are included in his report; administratively, such matters should be considered part of the present report. At several points joint matters are considered here.

A)

## COURSE REGISTRATIONS

1966-67

Fall 1966

| <u>Course Number</u> | <u>Number of Students Registered</u> |
|----------------------|--------------------------------------|
| PY101                | 245                                  |
| PY101E               | 111                                  |
| PY105                | 224                                  |
| PY105E               | 44                                   |
| PY111                | 43                                   |
| PY121H               | 49                                   |
| PY151                | 135                                  |
| PY201                | 95                                   |
| PY203E               | 13                                   |
| PY205                | 5                                    |
| PY301E               | 9                                    |
| PY303                | 13                                   |
| PY305                | 6                                    |
| PY307E               | 19                                   |
| PY309E               | 24                                   |
| PY311                | 9                                    |
| PY313                | 10                                   |
| PY703                | 3                                    |
| PY705                | 3                                    |
| PY711                | 12                                   |
| PY713                | 8                                    |
| PY717                | 11                                   |
| PY725                | 12                                   |
| PY777                | 6                                    |
| PY815A               | 4                                    |
| PY815B               | 3                                    |

## Course Registrations Continued:

Spring 1967

| <u>Course Number</u> | <u>Number of Students Registered</u> |
|----------------------|--------------------------------------|
| PY102                | 188                                  |
| PY102E               | 115                                  |
| PY106                | 150                                  |
| PY106E               | 76                                   |
| PY112                | 37                                   |
| PY122H               | 49                                   |
| PY152                | 120                                  |
| PY202                | 66                                   |
| PY204E               | 13                                   |
| PY206                | 11                                   |
| PY212                | 5                                    |
| PY302E               | 6                                    |
| PY304                | 11                                   |
| PY308E               | 21                                   |
| PY310E               | 18                                   |
| PY312                | 10                                   |
| PY314                | 7                                    |
| PY704                | 3                                    |
| PY712                | 10                                   |
| PY714                | 3                                    |
| PY718                | 5                                    |
| PY778                | 5                                    |
| PY812                | 10                                   |
| PY816A               | 5                                    |
| PY816B               | 3                                    |
| PY816C               | 4                                    |

## B) Graduate Student Affairs.

Professor George Zimmerman has become Chairman of the Committee on Graduate Admissions during Spring 1967. He has revised our pamphlet which deals with current research, and he is preparing a new brochure to be sent to physics departments and the prospective students. During the Spring there were 124 American students who applied for information and 139 foreign students who applied for information. Of these 63 Americans submitted formal applications and 49 foreign students applied. Figures on actual admissions and acceptances are not yet available.

Once again, it is unfortunately necessary to state that the Boston University stipend for Teaching Fellowships is so far below the stipends offered at competing institutions that we have lost almost all of the ablest applicants to whom we would have granted Teaching Fellowships. Most recently, it has become clear that this competitive situation applies equally to foreign applicants as to Americans. In my judgment the stipend must be raised from the present \$2,200 to \$2,600 in 1968-69; without such an increase we will see our sources of graduate students decline sharply. There is a well-documented shrinkage in the pool of eligible American graduating physics seniors, and with this there has been an increase in the number of competent graduate physics departments; and we must expect that the Government's threat to remove all draft exemptions for graduate studies including physics, will make the competition even more severe. Since these Teaching Fellows are essential to the undergraduate instruction, their stipends should be viewed as competitive salaries.

## Graduate Student Affairs.

The following students were supported by fellowships during 1966-67:

Teaching Fellowships

1. Bhagwat Ahluwalia
2. Raymond Arnold
3. Ramesh Chandra
4. James Coronos
5. Peter Farago
6. Mary Hulsing Fehrs
7. Mark Barry Goldman
8. Richard Hodges
9. Ernest Lacour
10. J. W. Mathews
11. John Oliver
12. Urbano Oseguera
13. Daniel Ostrowsky (part of 1st semester)
14. Maximos Papadopoulos
15. Marilyn Priolo
16. Harrison Ransom
17. P. D. Kameswara Rao
18. Laurence Rothman
19. Ram B. Singh
20. Joseph St. Amand
21. Duncan Watson
22. Peter Younger
23. Suck-Koo Yun
24. Peter Wintersteiner

NDEA

1. David Nartonis

NASA

1. Michael Horne
2. Henry W. Mullaney
3. Daniel Ostrowsky
4. John H. Porter

NSF Traineeships

1. Dennis Hamill
2. William J. Sarill

American Optical

1. Philip B. Newell

New York State Regents

1. Frank Kearly

The following students were supported by Research Assistantships for 1966-67:

1. John Brownson
2. Subhas Chandra
3. Hugh Churchill (undergraduate)
4. Rajendra Gupta
5. Phillips Hoeper
6. Woo Hyung Kahng
7. Chor Jin Koh
8. Michael Mendillo
9. David Miller
10. John O'Brien
11. Wijit Senghaphan
12. K. P. Singh
13. Samuel T. Scott

Graduate Student Affairs Continued.

The following students received Master of Arts degrees in August 1966:

Frank Feldman  
Arthur Snider  
Harriet Tamulonis

The following students received Master of Arts degrees in May 1967:

David Abeshouse  
Raymond Arnold  
Terence Elkins  
Henry L. Holcomb  
Michael A. Horne  
Frank Kearly  
Ernest Lacour ("Boundary Conditions and the Propagation of Electromagnetic Radiation")  
Henry Mullaney  
John Oliver  
Malcolm Skerry  
Peter Wintersteiner

The following students received the Ph.D. degree in May 1967:

Badri Aghassi, "Symmetry Algebras of Mechanical Systems"  
Subhas Chandra, "Mössbauer Studies of Nuclear Quadrupole and Hyperfine Interactions"  
Sebastian Genna, "Quantitative Determination of the Activity of in Vivo Gamma-Ray Emitting Radioisotopes by Whole-Body Counting"  
Chor Jin Koh, "On Higher Symmetries and Mass Spectrum of Elementary Particles"  
Samuel T. Scott, "Non-Perturbative Self-Consistent Field Theory of Gas Lasers"  
Suck-Koo Yun, "Discrete Symmetries and SU(3) in Non-Leptonic Weak Decays and in Electromagnetic Decays of Hadrons"

Graduate Student Affairs Continued.

The following students passed the Written Comprehensive Examination at the Masters level:

David Kelland  
Ernest Lacour  
J. W. Mathews  
Henry Mullaney  
Barbara Myrvaagnes  
Caleb I. Nwankwo

The following students passed the Written Comprehensive Examination at the Ph.D. level:

Raymond Arnold  
Kenneth Bernstein  
James Coronas  
Frank Feldman  
Michael A. Horne  
Frank Kearly  
David Miller  
David Nertonis  
John Oliver  
Ram B. Singh  
Malcolm Skerry  
R. Wenstrup  
Peter Wintersteiner

## C) Undergraduate Affairs.

There has been an increase in physics majors, although the number is very small, and it is too early to tell whether there has been an average increase. One rough indication is that three years ago when FY151 was first given, there was only one explicit declared physics major freshman in the course. This year there are five.

A notable change in our curriculum has been the institution of honors sections accompanying the first two years of the physics major sequence; honors sections have been formed accompanying other introductory physics courses as well. These seem to have gotten off to a successful start; the big problem is to make the honors section rich enough to justify its existence as an ancillary to the main lecture. A possible obvious extension for the future is the institution of honors laboratories.

Another noteworthy aspect of undergraduate affairs during this last year has been a somewhat increased emphasis on lecture demonstrations. This has been spurred by the availability of Federal funds for the purchase of rather elaborate demonstration equipment and by the availability of a new lecture room (on the site of the old Chenery Library) complete with preparation room. This new room not only will be more suitable for demonstrations than room 50 in the Stone Building, but the move from room 50 has made it necessary for us to sort out generations of equipment. We are fortunate that both the old and the new demonstration equipment is being attended to by a graduate student who has had a good deal of teaching experience, namely Mr. Harrison Ransom. A particularly striking and useful piece of lecture demonstration equipment which has been recently acquired is a very large demonstration air track.

Concerning the upper curriculum, an important issue which will face the faculty is the relative importance of courses and honors work for qualified physics majors. In this connection an Undergraduate Committee recommendation to furnish three semesters rather than two semesters of atomic and nuclear physics was deferred until this issue as well as the issue of the efficacy of the four semester introductory course has been sorted out.



#### Undergraduate Affairs Continued:

Up to now our main experience with project work has concerned the hiring of undergraduates for summer work. These undergraduates have been employed both as research technicians on research projects and in the setting up of lecture demonstrations and experiments. There has been something of a paucity of regular honors candidates in physics, no physics major having actually completed his honors work for the last four years. During that time in fact, there has only been one honors candidate. Next semester however there will be two honors candidates doing projects. Mr. Carl Cohen will work in the Mössbauer laboratory, and Mr. Christopher Hagen will do a nuclear project. It might be added incidentally that Carl Cohen is working at Brookhaven National Laboratory during Summer 1967.

Two possible future opportunities for undergraduate research participation should be mentioned. Through the good offices of Professor Lichtin of the Chemistry Department a system has been worked out whereby very well-qualified Boston University undergraduates will be appointed to Brookhaven summer research posts without going through the usual competitive channels. In addition a National Science Foundation undergraduate research participation grant is being applied for at the present time. If obtained, this grant will allow undergraduate physics majors to work here summers for a stipend and will furnish a small amount of money to cover their projects.

It would be of interest to make a systematic study of where our undergraduates go for graduate work and how they fare. Typically those of our graduates who do go to graduate school get teaching fellowships or straight fellowships at good but not outstanding graduate schools. Typical schools are Tufts and the University of Massachusetts. This year Mr. Sam Savage (essentially a physics major although officially a mathematics major) received a fellowship to the Yale School of Applied Science. Another student, Mr. Stephen Saslow, received a fellowship at the University of Missouri.

Undergraduate Affairs Continued:

There is a nagging suspicion that Boston University students do not do quite as well as they should when it comes to graduate school admission. However we have hardly had a plethora of excellent and well-prepared students, so that the suspicion is hardly confirmed. It will be interesting to see what happens next year, when we will have at least two very well-qualified graduates and several other promising ones.

## D) Research.

I attach a preliminary copy of the description of Current Research in the Department of Physics which was prepared during Spring 1967. (The bibliographies cover more than 1966-67; the annual bibliography is part 9 of this report).

Of particular note this year has been the flourishing of research discussions both with visitors and among the faculty and research students in the Department. I quote from a brief report by Professor John Stachel, who most effectively undertook to arrange the regular Department Colloquium and also the program of Distinguished Visitors.

This year was marked by a rather full Colloquium schedule, highlighted by the visits of a number of outstanding physicists, and closely tied into the research interests of the Department. In large measure this was the result of the granting of \$1,900 by the Graduate School for a series of Distinguished Visiting Scholars. This money was used to cover the expenses, including honoraria, of six distinguished physicists, who stayed for several days each, and gave a number of seminars and colloquia (see starred items on attached list for these). These formal talks, as well as the extensive informal contact with faculty and graduate students working in the same areas as the visitors, were highly beneficial to the work of the Department. They contributed significantly to the liveliness, morale and prestige of the Department, in addition to the obvious scholarly benefits. It is the unanimous feeling of the members of the Physics Department that the Graduate School is to be congratulated for initiating this program; and that it should be made a regular part of the Graduate School program.

As may be seen from the list, a number of other distinguished visitors also gave Colloquia during the year.

The regular Physics Colloquia were:

- September 21, 1966 - "Generalized Functions in Physics" - Werner Güttinger  
(Munich)
- October 19, 1966 - "Nonlinear Optical Properties of Metals" - Fielding Brown  
(Williams)
- October 26, 1966 - "Quantum Measurement and Irreversibility" - Peter Bergmann  
(Syracuse)
- November 16, 1966 - "Mössbauer Resonance Studies of Spin Relaxation Effects  
in Diluted Ferric Ions" - Sergio De Benedetti  
(Carnegie Institute of Technology)
- November 30, 1966 - "Quantum Theory of the Gas Laser" - Charles R. Willis  
(Boston University)
- December 14, 1966 - "X-Ray Astronomy" - Philip Morrison (M.I.T.)
- January 4, 1967 - "Short History of Sporadic E Research" - Ernest K. Smith  
(Harvard Observatory)
- February 8, 1967 - "Measurement of the Quadrupole Moment of the Sun" -  
H. M. Goldenberg (Princeton)
- \* February 15, 1967 - "Particle Physics in Terms of Non-Invariance Groups" -  
George Sudarshan (Syracuse)
- March 1, 1967 - "Polarized Particles from Metastable Hydrogen Atoms" -  
Bailey L. Donnelly (Yale)
- \* March 8, 1967 - "Some Recent Rigorous Results in Statistical Mechanics" -  
Joel L. Lebowitz (Yeshiva)
- \* March 15, 1967 - "The Study of Critical Phenomena in Antiferromagnets Using  
the Mössbauer Effect" - G. Wertheim (Bell Telephone Lab.)
- March 29, 1967 - "The Kirkhoff-Planck Radiation Law and the Rise of Quantum  
Mechanics" - Joseph Agassi (Boston University,  
Department of Philosophy)
- \* April 5, 1967 - "The Giant Dipole Resonance and Nuclear Structure" - Peter Axel  
(University of Illinois)
- April 12, 1967 - "Type I Supernovae" - Arrigo Finzi (M.I.T.)
- \* May 3, 1967 - "Gravitational Radiation" - Andrzej Trautman (Inst. Theoretical  
Physics, Warsaw)
- \* May 10, 1967 - "Active Gravitational Mass, the Expansion of the Universe and  
Quasars" - K. R. Atkins (University of Pennsylvania)
- May 17, 1967 - "Simple States in Complex Nuclei" - R. A. Peck (Brown)

The Seminar on Space Science, organized and conducted by Professor Michael Papagiannis, consisted of the following sequence of speakers:

- September 19, 1966 - "Introduction to the Space Science Seminar" - Michael D. Papagiannis (Boston University)
- September 26, 1966 - "The Lunar Surface Layer" - John W. Salisbury (Air Force Cambridge Research Laboratories)
- October 3, 1966 - "Motions of Planetary Atmospheres" - Peter H. Stone (Harvard University)
- October 10, 1966 - "Some Physiological Considerations of Space Flights" - David E. Bass (U. S. Army Lab. for Environmental Medicine)
- October 17, 1966 - "The Earth's Magnetosphere" - Norman F. Ness (NASA, Goddard Space Flight Center)
- October 24, 1966 - "The Solar Wind and its Interaction with the Geomagnetic Field" - Robert L. Carovillano (Boston College)
- October 31, 1966 - "Microwave Background Radiation and its Relation to Cosmology" - Arno A. Penzias (Bell Telephone Lab.)
- November 7, 1966 - "Planetary Nebulae" - William Liller (Harvard University)
- November 14, 1966 - "Space Telescopes" - Robert E. Danielson (Princeton University)
- November 21, 1966 - "Stellar Evolution" - Icko Iben, Jr. (M.I.T.)
- November 28, 1966 - "Calculation of the Orbits of the Planets" - Gerald M. Clemence (Yale University)
- December 5, 1966 - "The Chemistry of Nitrogen Atoms" - Norman N. Lichtin (Boston University, Department of Chemistry)
- December 12, 1966 - "Propagation of Radio Waves in Ionized Media" - Michael D. Papagiannis (Boston University)
- January 30, 1967 - "Space Radio Astronomy" - Michael D. Papagiannis (Boston University)
- February 6, 1967 - "Rocket Investigations of the Lower Ionosphere" - J. A. Kane (NASA, Goddard Space Flight Center)
- February 13, 1967 - "Airglow and Aurora" - Sam M. Silverman (Air Force Cambridge Research Laboratories)
- February 20, 1967 - "Radio, X-ray, and Optical Emission from Solar Flares" - Alan Maxwell (Harvard University)
- February 27, 1967 - "Magnetic Storms in the Earth's Exosphere" - Laurence J. Cahill (University of New Hampshire)
- March 6, 1967 - "Space Medicine" - Const. D. J. Generales (Mount Sinai School of Medicine)

## Seminar in Space Science Continued:

- March 27, 1967 - "Stellar Interiors" - Lloyd Motz (Columbia University)
- April 3, 1967 - "The Generation of Galactic Radio Noise" - Bernard S. Burke  
(M.I.T.)
- April 10, 1967 - "Meteorological Satellites" - William K. Widger, Jr.  
(Allied Research Associates, Inc.)
- April 17, 1967 - "Scientific Studies from Satellite Tracking" - Charles A.  
Lundquist (Smithsonian Astrophysical Observatory)
- April 24, 1967 - "The Heat Shielding of Manned Satellite" - Coy L. Huffine  
(AVCO-Space Systems Division)
- May 1, 1967 - "Topics in Cosmology" - P. James E. Peebles (Princeton  
University)
- May 8, 1967 - "X-ray Astronomy" - Herbert Gursky (American Science &  
Engineering)

## Research.

The Boston Colloquium for the Philosophy of Science, conducted in association with philosophers, physicists, and other scientists, presented a number of Colloquia of interest to this Department:

- October 10, 1966 - "Newton's Use of Hypotheses: Conflicting Interpretations of Philosophers and Historians of Science"  
I. Bernard Cohen (Harvard University)  
Commentator: Norwood Russell Hanson (Yale University)
- October 25, 1966 - "The Quantum State Vector and Physical Reality"  
Peter Bergmann (Syracuse University)  
Commentator: Hugh Pendelton (Brandeis University)
- December 13, 1966 - "Symmetry in Physics"  
Paul Roman (Boston University)  
Philip Morrison (M.I.T.)
- January 9, 1967 - "Mach Today: Symposium"  
Milic Capek (Boston University, Philosophy)  
Robert S. Cohen (Boston University, Physics)
- January 24, 1967 - "Three Studies in the Philosophy of Space and Time"  
Zdzislaw Augustynek (Jagiellonian University, Krakow)
- February 27, 1967 - "Causal Connection"  
William Ruddick (M.I.T.)  
Commentator: Melvin Schuster (Boston University)
- March 20, 1967 - "On Empiricism in Mathematical Philosophy"  
Imre Lakatos (London School of Economics)  
Commentator: Jean van Heijenoort (Brandeis University)
- April 17, 1967 - "Causality and the Concept of Scientific Law"  
Mihailo Markovic (University of Belgrade)

## Research Continued.

In addition several members of the faculty held regular seminars in their research fields. These included Professor Hoy's seminar on Mössbauer physics, Professor Stachel's seminar on relativity physics, Professor Franzen's seminar concerned with his research on production of a stream of polarized electrons and the seminar on nuclear physics conducted by Professors Alston, Booth, and Chasan. Much of this activity was conducted without formal course credit; the spontaneous development of such working groups is a noteworthy sign of the involvement of students and professors in active research.

## Partial Listing of the Mössbauer Seminar:

- October 12, 1966 - "Spin Hamiltonian Methods in Mössbauer Spectroscopy"  
G. R. Hoy (faculty, Boston University)
- October 19, 1966 - "Analysis of Mössbauer Effect Data by Least Squares Analysis"  
Richard Bell (graduate student, Boston University)
- October 26, 1966 - "Time Dependent Mössbauer Spectroscopy III"  
Dennis Hamill (graduate student, Boston University)
- November 2, 1966 - "Determination of Effective Field Parameters in Mössbauer Spectra"  
Subhas Chandra (graduate student, Boston University)
- November 9, 1966 - "Discovery of Two Effective Magnetic Fields in  $\text{Fe}_3(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$ "  
Subhas Chandra (graduate student, Boston University)
- November 16, 1966 - "Mössbauer Effect in  $\text{SrTiO}_3$  and Other Ferroelectrics"  
Richard Bell (graduate student, Boston University)
- November 23, 1966 - "Calculations of EFG for  $\text{Tm}^{2+}$  in  $\text{CaF}_2$ "  
K. P. Singh (graduate student, Boston University)
- November 30, 1966 - "Time Dependent Mössbauer Spectroscopy IV"  
Dennis Hamill (graduate student, Boston University)
- March 13, 1967 - "Pulse Shape Characteristics of our Mössbauer Electronics"  
Dennis Hamill (graduate student, Boston University)
- March 20, 1967 - "Time Mode Operation in Mössbauer Spectroscopy"  
Richard Bell (graduate student, Boston University)



Research Continued.

Mossbauer Seminar

- March 27, 1967 - "Hyperfine Fields I"  
G. R. Hoy (faculty, Boston University)
- April 3, 1967 - "Source and Absorber Materials Preparation"  
Dennis Hamill (graduate student, Boston University)
- April 10, 1967 - "Hyperfine Fields II"  
Subhas Chandra (graduate student, Boston University)
- April 17, 1967 - "Delayed Coincidence Mossbauer Effect I"  
Dennis Hamill (graduate student, Boston University)
- April 24, 1967 - "Group Theory in Solid State I"  
G. R. Hoy (faculty, Boston University)

The following talks comprised the Relativity Seminar:

- October 3 and 10, 1966 - "Algebraic Classification of Spherically Symmetric Einstein Tensors"  
John Stachel (faculty, Boston University)
- October 17, 1966 - "Pauli Algebra and Structure of Lorentz Group"  
Laszlo Tisza (M.I.T.)
- October 26, 1966 - "Hamilton-Jacobi Theory with Constraints"  
Peter Bergmann (Syracuse University)
- November 14, 1966 - "Null H Pervsurface Analysis of Electromagnetic Field"  
John Stachel (faculty, Boston University)
- November 28, 1966 - "Neutron Stars"  
Arrigo Finzi (M.I.T.)
- December 5, 1966 - "Interacting Fields of Spin 2 and the Einstein Equations"  
Gustave Gonzales-Martin (graduate student, Boston University)
- January 9, 1967 - "Asymptotic Properties in General Relativity"  
Richard L. Arnowitt (Northeastern University)
- February 3, 1967 - "Comparison Between Newton's and Einstein's Theories of Gravitation"  
Jurgen Ehlers (University of Texas)
- February 14, 1967 - "Relativistic Interaction Corrections in Statistical Mechanics"  
John Krizan (University of Vermont)

Research Continued.

Relativity Seminar

- February 20, 1967 - "Relativity and Invariance"  
Jan Post (Air Force Cambridge Research Laboratories)
- February 28, 1967 - "Embedding of Einstein Spaces in Pseudo-Euclidean Spaces"  
Joseph Rosen (Brown University)
- March 16, 1967 - "Perturbational Approach to Solution of the Einstein Equations"  
Laurence Rothman (graduate student, Boston University)
- March 28, 1967 - "The Non-Relativistic Limit of the Poincaré Group"  
Owen Fleischman (faculty, Boston University)
- April 6, 1967 - "Stationary Rotating Masses in General Relativity"  
William J. Sarill (graduate student, Boston University)
- April 11, 1967 - "Energy of Nonsingular Solutions to Einstein's Equations"  
Dieter Brill (Yale University)
- April 25, 1967 - "Singularities in Space-Time"  
Roger Penrose (Cornell University)
- May 4, 1967 - "Geometrization of the Electromagnetic Field"  
Andrzej Trautman (Warsaw)
- May 9, 1967 - "On Relativistic Statistical Mechanics"  
Remi Haki (Orsay, France)

Publications this year were at approximately the same rate as last year, about sixty in all.

This may be an appropriate point to comment on the Carter Report, or more formally the "American Council on Education Study of Graduate Education". I excerpt from my memorandum to the physics faculty of January 13, 1967:

At a recent meeting of the Graduate School Cabinet (chairmen of departments which offer graduate degrees), Dean Kubzansky distributed confidential reports on the different departments. Those who made the ratings of departments include a very large number of accepted leaders in each field, for example prize winners, chairmen, fellows of professional societies, and so forth. The number of institutions evaluated includes all who gave a Ph.D. during 1952-62, namely 86. 190 individuals made the actual ratings. Of the 86, 49 were considered adequate or better. Boston University physics ranked somewhere about 60-69 out of 86; the 10th in which our department falls is 8. In the actual report, those departments were listed which

## Research Continued.

were considered to be better than adequate. We were not so listed and one might think that the appropriate word is "inadequate". However this judgment depends on several other factors. The percent of evaluators who stated that they knew too little about the B.U. physics department to rate it was 47%. Furthermore if we include only those who know the department, their distribution of evaluation is as follows:

| <u>Distinguished</u> | <u>Strong</u> | <u>Good</u> | <u>Adequate</u> | <u>Inadequate</u> |      |
|----------------------|---------------|-------------|-----------------|-------------------|------|
| 0                    | 0             | 16          | 47              | 37                | in % |

It appears that 63% therefore considered our department adequate or better.

The ratings were made in late 1963, and one must presume that those who made them could only base their opinion on direct or hearsay evidence which was largely from some time earlier in 1963, in any case, five years or more ago.

We have here a professional judgment which is sober and, within certain boundaries, probably quite accurate. The ratings evidently don't reflect rates of change among departments, and they are already out of date. Moreover they cannot reflect the quality of young faculty members, and our department is largely made up of younger people. This needs no argument, but it is strikingly exhibited by the fact that we have had not one retirement in 10 years with no prospect of a retirement for another 15 years. A quarter of a century without retirements signifies a remarkably young department chronologically at least.

The rating might or might not have been different if made today. It is not clear also whether our reputation does not also significantly depend upon our "image" and hence whether a change would not require an ambitious effort to become known professionally.

Finally, reflecting GRS discussion, it must be faced that this large report with the subtitle "an assessment of quality in graduate education" can be self-confirming. Thus if undergraduate seniors seek advice about graduate school to attend, they and their advisors will almost surely turn to the 49 physics departments which were listed by name as adequate or better. The competition for good students therefore is made worse for us by this report, whatever

## Research Continued.

its merits and objectivity. We have now, and have had in the past, a remarkable number of excellent student, but it is also remarkable that most of them have come to us by marginal or unusual routes. We are therefore, I believe, still quite dependent upon these modes of recruitment, that is to say, upon soliciting excellent foreign students, part-time students from the Boston area, students of teachers who are professionally or personally appreciative of an individual on our faculty and so forth.

In the same memorandum, I commented further about the Department as follows:

I tried to find an accurate gauge of our present standing among departments. Aside from any considerations of "image", it would be useful to us, and probably to our Deans and other administrative officers, to have such. My best immediate source, it seems to me, is the representation of departments from the East at the Annual Meeting of the American Physical Society. There has been no pressure administratively over the past years to produce results for the annual meeting, and so far as I know, this has not been true this year either. I rather imagine our department is similar to others. In any case here are the data, obtained by my fairly accurate count while reading the program. I put mid-west, southern, and western institutions in parentheses, and I underline those institutions which probably should be considered within our general geographical competitive area.

Numbers beside each institution indicate number of papers to be given at that meeting.

|                      |    |                       |    |                   |     |
|----------------------|----|-----------------------|----|-------------------|-----|
| <u>Cornell</u>       | 12 | <u>Michigan State</u> | 16 | <u>Rochester</u>  | 15  |
| <u>Duke</u>          | 12 | <u>Pittsburgh</u>     | 13 | <u>Toronto</u>    | 14  |
| <u>Maryland</u>      | 16 | <u>Purdue</u>         | 13 | <u>Yale</u>       | 20  |
| (Berkeley            | 9) | <u>Chicago</u>        | 9  | <u>Rensselaer</u> | 11  |
| →→→→→→→→→→ Boston U. | 10 | <u>Columbia</u>       | 8  | <u>Stanford</u>   | 10) |
| <u>Brown</u>         | 10 | <u>M.I.T.</u>         | 11 | <u>Virginia</u>   | 8   |
| <u>Catholic U.</u>   | 10 | <u>Penn</u>           | 8  | <u>Wisconsin</u>  | 9   |

## Research Continued.

|                       |  |  |   |  |
|-----------------------|--|--|---|--|
|                       | Illinois 7   | <u>Carnegie Tech</u> 6   | <u>Case-Western Reserve</u> 6   | <u>Harvard</u> 6   |
| <u>5 papers each:</u> | <u>Buffalo</u><br>(California-Riverside)<br>(Colorado)<br>(Florida)  | Ohio State<br>Michigan<br><u>NYU</u><br>(U. of Washington)                               | <u>Princeton</u><br><u>Syracuse</u><br>(U. of Arizona)<br><u>Wayne State</u>            |  |
| <u>4 papers each:</u> | <u>Delaware</u><br>(Florida State)<br>Indiana<br><u>Montreal</u>   | Nebraska<br>(N. Carolina State)<br><u>Rutgers</u><br>(Texas)                             | (Texas A & M)<br>(UCLA)<br>(W. Virginia)  |  |
| <u>3 papers each:</u> | (Cal Tech)<br>Illinois Tech  | Iowa<br>(Kansas State)   | (New Mexico)<br>Northwestern  |  |
| <u>2 papers each:</u> | (Arizona State)<br><u>Brooklyn Poly</u><br>(California-Davis)<br><u>Clarkson Tech</u>                          | <u>Connecticut</u><br><u>Dartmouth</u><br><u>Johns Hopkins</u><br>(Louisiana State)      | Missouri<br><u>Notre Dame</u><br><u>S. East Mass. Tech.</u><br><u>N. Carolina</u>       |  |
| <u>1 paper each:</u>  | (Alabama)<br><u>Boston College</u><br>(Calif-La Jolla)<br><u>CCNY</u><br>(Georgia)<br><u>George Washington</u> | (Kansas)<br>Kent State<br><u>Lehigh</u><br>Manitoba<br><u>Marquette</u><br><u>McGill</u> | McMaster<br>(Nevada)<br><u>Northeastern</u><br>Oberlin<br>Oklahoma<br><u>Penn State</u> | Puerto Rico<br>Rhode Island<br><u>U. Mass. Boston</u><br><u>Vanderbilt</u><br>(Washington State)<br>Wisconsin at Milwaukee |
|                       | <u>Brandeis</u> 0  |  |   |  |
|                       | <u>Tufts</u> 0   |  |   |  |

## E) Faculty Notes.

During the Fall of 1966 Professor Hawkins was on sabbatical leave, and Professor Cohen served as Acting Chairman of the CIA Department of Astronomy. During Spring and Summer of 1967, Professor Cohen was on sabbatical leave; Professor Stipe served as Acting Chairman during the first half of the Spring term, and Professor Franzen during the remainder of the term as well as during the Summer.

Professor Stipe will be on sabbatical leave during the academic year 1967-68. Dr. Joshua Shuchatowitz of the Stevens Institute of Technology research group at Air Force Cambridge Research Laboratories, has been appointed Lecturer in Physics for 1967-68; he is on leave from the Department of Physics at Yeshiva University. Dr. Ransom Marlow of Spring Hill College, Mobile, Alabama, has been appointed as Visiting Assistant Professor for 1967-68; Father Marlow will continue his research on logical foundations of quantum theory, and he will be associated with the Philosophy of Science Colloquium as well as teach a course in theoretical physics.

General faculty notes are given below. However a number of highlights deserve separate note.

Professors Alston, Booth, and Chasan have been invited to join the regional linear accelerator project which has been organized at M.I.T.; they are participating in the international photonuclear study program at M.I.T. during the Summer of 1967.

Professor Franzen has been invited to speak at the Vth International Conference on Atomic Collisions, at the Academy of Sciences of the U.S.S.R. in Leningrad during July 1967; he is there as this report is being written. Professor Franzen has also been invited to serve as Chairman of the New England Regional Selection Committee of the Woodrow Wilson Foundation.

## Faculty Notes Continued.

Professor Roman was Visiting Professor at the Institute for Theoretical Physics of the University of Frankfurt during part of the Spring term; he was also an invited speaker at the Conference on Relativistic Astrophysics and Elementary Particles at Temple University in Philadelphia during February.

It is also noteworthy that the work of our high energy theorists, Professors Fleischman, Hellman, Roman and their students has become sufficiently known nationally and internationally, that the normal reprint requests for publications has risen to 250.

Professor Siegel's work has been recognized in two interesting ways. The standard work Fluctuations in Solids (edited by Ronald E. Burgess, New York 1965) contains a chapter by N. G. van Kampen, "Fluctuations in Nonlinear Systems" in which section IIIE is entitled "Siegel's Expansion". P. G. Saffman's "Lectures on Homogeneous Turbulence" (International School of Non-Linear Physics and Mathematics, Max Planck Institute, Munich, July 1966) contains the following passage:

"A method of some promise has been pointed out by Meecham and Siegel...The application to the Navier-Stokes equations has not yet been carried out, but is awaited with interest. There will doubtless be a flood of papers in the next decade.... The method is certainly attractive. It is conceptually very simple and has a sound physical basis.... All told, the Wiener-Hermite expansion [the method introduced by Meecham and Siegel] would appear to be the most promising and least objectionable of all the truncation schemes, and although optimism may be unfounded, it gives hope that a satisfactory analytical description of homogeneous turbulence may be obtained fairly soon."

## Faculty Notes Continued.

Professor Stachel spent the month of June 1966 at Temple University where Dr. Peter Havas heads a group working in general relativity; and the months of July and August were spent at the Centro de Investigacion y de Estudios Avanzados del I.P.N. in Mexico City, where Jerzy Plebanski heads a group working in this field. This summer, Dr. Stachel has been invited back to the Centro as Visiting Professor, and will spend four months there.

Professor Stipe's book The Development of Physical Theories appeared in print as this report is being written.

Professor Cohen has been asked to join the editorial boards of several journals: Synthese (An International Journal for Epistemology, Methodology and Philosophy of Science, published in Dordrecht, Holland), Praxis (international edition published in Zagreb, Yugoslavia), Colloquy, a journal of inter-disciplinary studies (to be published by the Society for Religion in Higher Education in New Haven, Connecticut).

Two other notes about faculty affairs: Professor Cohen exercised the faculty and others by considering at some length and finally declining a two-year appointment at UNESCO. Professor Chasan delivered the most stimulating lecture in a series for the Boston University Graduate Wives; his topic was "Intelligent Life in the Universe".



## Faculty Notes.

William J. Alston

- 1) "PY105-106 (Elementary Physics) was made more sophisticated for a special honors group (two sections of twelve students each) which I instructed. The sections were not listed in the course catalogue. Talks with (Atkins) the author of the text used in the course coupled with efforts to upgrade the laboratories have resulted in a course that quite satisfactorily serves the needs of advanced non-physical science students (biology, geology, etc.).
- 2) "The experience of teaching PY301 (Modern Physics) to our senior physics majors led me to propose an augmented and more detailed "Modern Physics" sequence, which would contain three semesters (to begin in the second half of the junior year), rather than the present two semester sequence, as an option for our better students. The Undergraduate Affairs Committee recommended the change which is to be discussed by faculty in Fall 1967."

Edward C. Booth

Professor Booth attended the Gordon Conference on Photonic Physics in July 1966; with two of his graduate students (John Brownson and Henry Wilson) he presented research papers to the Annual Meeting of the American Physical Society in New York in February.

Professor Booth served on the GRS Research Policy Committee, the CIA Academic Standards Committee, and the Inter-University Planning Committee for the M.I.T. Photonic Summer Study Conference.

## Faculty Notes Continued.

## Bernard Chasan

Professor Chasan delivered a lecture on "Models of Nuclear Structure" at the New England High School Science Congress in Springfield last Fall. He attended the Gordon Conference on Nuclear Structure in June 1966, and he gave a research paper to the Annual Meeting of the American Physical Society in February.

Professor Chasan served on the GRS Academic Programs Committee, the CIA Library Committee (to which he has been elected Chairman for 1967-68), and also the CIA Special Committee on R.O.T.C. Within the Department, he is Chairman of the Committee on Undergraduate Affairs and also a member of the Library Committee and the committee on planning a new building.

## Robert S. Cohen

Professor Cohen lectured at the American University N.S.F. Institute on History and Philosophy of Science in June 1966 and again in June 1967. He served as a member of the American delegation to the International Conference on Science and Technology on Underdeveloped Countries at Herceg-Novci, Yugoslavia in July 1966. He lectured at the Boscovic Institute of Nuclear Physics in Zagreb during July 1966. In September he served as commentator to a paper by Isaac Deutscher at the Socialists Scholars Conference in New York. He lectured at the Eagleton Institute at Rutgers University on October 12th, the Community Church in Boston in October, the American Friends Service Committee Conference in Cambridge in November, the continuing science discussion group at Boston College in November, the Conference of the Church Society for College Work at the Harvard Divinity School in December, the Ethical Culture Association on December 4th; he delivered an invited paper

## Faculty Notes Continued.

at the Mach Symposium of the American Association for the Advancement of Science in December and also at the Symposium on Social Aspects of the Philosophy of Technology at the AAAS meeting; he gave invited lectures to the Boston Colloquium for the Philosophy of Science in January, the Putney School in Vermont in February, the Harvard-SDS lecture series in March, the U. S. National Committee for the Christian Peace Conference in April, the "Symposium on Unpopular Views and Unfair Criticism on the History of Science" in honor of the retirement of Giorgio di Santillana of M.I.T. in May, and he participated in the Conference on the History of Nuclear Physics sponsored by the American Physical Society and the American Academy on May 18-19. He continued as a staff member of Harvard Project Physics.

He served on the GRS Committee on Graduate Education in the Arts and Sciences, and on the Committee on Graduate Education and Research as part of the Committee on the Future of the University. Also he was a member of the Metropolitan College Faculty Board elected from CLA. He is a member of the Executive Committee of the New England Section of the American Physical Society. He continued as Chairman of the Boston Colloquium for the Philosophy of Science, member of the U. S. National Committee for the International Union of the History and Philosophy of Science (appointed from the Philosophy of Science Association by the U. S. National Academy of Science), Chairman of the American Institute of Marxist Studies, member of the Boston Area Faculty Group on Public Issues, member of the Executive Committee of the Emergency Civil Liberties Committee and a member of the Board of Directors of the Bill of Rights Foundation.

## Faculty Notes Continued.

## Ernesto Corinaldesi

Professor Corinaldesi held a series of informal seminars on "Pressure Broadening of Spectral Lines" which was associated with his work as consultant with the Westinghouse Research and Development Center. He has served on the Department Library Committee.

## Dean S. Edmonds, Jr.

Professor Edmonds spoke on his development of a new electronics teaching laboratory to the Spring Meeting of the New England Section of the American Association of Physics Teachers in April. Within the Department he has served as Director of Research Services. He is also a member of the CIA Committee on Pre-Medical Students; he will serve as the Chairman of this committee during 1967-68.

## Owen Fleischman

Professor Fleischman spoke to the Brown University Theoretical Physics Colloquium in April. He served as a judge at the Massachusetts State Science Fair in the same month.

## Wolfgang Franzen

Professor Franzen delivered a Colloquium at the Yale University Physics Department in November; he spoke at the Washington Meeting of the American Physical Society in April; and during the year he delivered a series of twelve lectures at the Mitre Corporation.

## Faculty Notes Continued.

Professor Franzen agreed to serve as Acting Chairman during the Spring and Summer 1967. This burden was taken in addition to a number of other University activities. He serves as Chairman of the GRS Committee on Faculty and Committee Membership. He was a member of the GRS Ad Hoc Committee on the Lines of Academic Responsibility in the Graduate School. Within CLA he serves as a member of the Honors Committee, and in addition he has served on the Ad Hoc Committee on Distribution Requirements, and he is active now as a member of the Advisory Selection Committee for the Dean of CLA. Within the Department, he has for some years served as Chairman of the Committee on Graduate Studies, and in addition during this past year as Chairman of the Department Building Committee. In the latter connection he is the physics member of the University Planning Committee for the New Science Building.

Professor Franzen reviews for Mathematical Reviews, and he serves as a member of the Board of Editors of the journal Zeitschrift für Angewandte Mathematik und Physik.

## William S. Hellman

Professor Hellman spoke to the Physics Colloquium at Syracuse University during the Spring.

## Gilbert R. Hoy

Professor Hoy spoke at the Annual Meeting of the American Physical Society in February.

## Faculty Notes Continued.

## Paul Roman

Professor Roman delivered lectures and seminars at the following places: Quantum Physics Laboratory of Thompson-Ramo-Wooldridge in Los Angeles during July 1966; Boston College Physics Colloquium in October; University of Frankfurt, April 15-May 30; University of Mainz Physics Colloquium, April; Technical University of Darmstadt, April; University of Munich, May; Heisenberg group at the Max Planck Institute in Munich in May; University of Marburg, May; University of Würzburg, May. He was an invited member of the Conference on Theory of Elementary Particles, Boulder, Colorado, July 1967, also of the Fifth Eastern United States Theoretical Physics Conference, Providence November 1966, and the Relativistic Astrophysics and Elementary Particles Conference, Temple University, February 1967.

Three of Professor Roman's graduate students (B. M. Aghassi, G. J. Koh, and S. K. Yun) received their doctorates in May 1967. [Noting that in the whole U. S. the annual number of Ph.D's granted in high energy physics (including experimental work) is about 350, this number appears to be a sign that Boston University contributes significantly to the development of this field.]

## Armand Siegel

Professor Siegel has served as Chairman of the Committee on the Comprehensive Examinations. He is Censor of the Department Bulletin Board.

## Faculty Notes Continued.

## John Stachel

During the last year Professor Stachel has made important progress in establishing research in general relativity as a field of activity of the Boston University Physics Department, and getting this known in the physics community.

A regular seminar in Relativity has been established, with the help of a small grant from the College of Liberal Arts and has been visited by a number of distinguished research workers in the field, some with an international reputation. This has proved a most stimulating way of keeping both faculty and students working or interested in this field in touch with current developments. A list of the talks will be found above.

Dr. Andrzej Trautman, who holds the Chair of Electromagnetic Theory and Relativity at the University of Warsaw, an internationally acknowledged expert in general relativity and author of numerous studies and review articles in this field, was a guest of the Department for several days under the Visiting Distinguished Scholar program sponsored by the Graduate School. Faculty and students benefitted greatly from both formal and informal contacts with him.

It may not be out of place to point out that, as a result of Dr. Tulczyjew's visit to Boston University as holder of an N.S.F. Distinguished Senior Foreign Scientist award last year (see last year's report), one of our graduate students, Mr. James Coronas, has been invited to spend one year at the Institute for Theoretical Physics in Warsaw, working with the Polish relativity group, headed by Leopold Infeld.

## Faculty Notes Continued.

Dr. Stachel has been participating in the Stevens Institute Conferences on General Relativity, a series of informal conferences held about six times a year and attended by most workers in the field living in the northeast, for the last few years. Thanks to a small grant from the Graduate School, he was able last semester to go to these conferences with several graduate students, who benefitted from being able to hear and talk with leading workers in the field -- an important advantage particularly for a small group.

Dr. Stachel delivered the following lectures:

"Criteria for Outgoing Radiation in General Relativity" at Temple University Theoretical Seminar, June 1966;

"Problem of Gravitation Radiation" at the Seminar of Atomic Energy Commission of Mexico, August 1966;

"Criteria for a Theory of Gravitation: A Modern Case for General Relativity" at the Brown University Colloquium, March 1967;

"Bondi-Sachs Type of Analysis for the Electromagnetic Field" at the Syracuse University Relativity Seminar, April 1967;

"Classification of the Einstein Tensor" at the Yale University Relativity Seminar.

In addition to the Stevens Conferences, he attended the Conference on Relativistic Astrophysics and Elementary Particles, Temple University, February 1967; the Fifth Eastern States Theoretical Physics Conference, Brown University, November 1966; the "Texas" Conference on Relativistic Astrophysics, New York City, January 1967; and the New York Meeting of the American Physical Society, New York City, January 1967.



Faculty Notes Continued.

J. Gordon Stipe, Jr.

Professor Stipe served as Secretary and Treasurer, as well as Director, of the New England Section of the American Association of Physics Teachers. He has been a representative to the Senate Council elected by the Graduate School Faculty and also a member of the University Committee on Graduate Education, one of the special committees on the Future of the University, as well as a member of the Coordinating Committee for the latter purpose. He served as Acting Chairman for part of the Spring semester 1967.

Charles R. Willis

Professor Willis lectured at the University of Utrecht in June 1966. He spoke at the Annual Meeting of the American Physical Society in February and again at the Washington meeting (with his research student, Samuel T. Scott) in April.

During the year he instituted a new seminar on the Interaction of Radiation and Matter.

George O. Zimmerman

Professor Zimmerman served as Chairman of the Graduate Admissions Committee in the Department and as a member of the Committee on the Comprehensive Examinations.

## Faculty Notes Continued.

In addition to the regular teaching faculty, we have been joined by a number of Post-doctorate Research Associates during the year:

Dr. Zdzislaw Augustynek worked with Professor Cohen,

Dr. Shin Ishida worked with Professor Roman,

Dr. Steven Newman worked with Professor Siegel,

Dr. Olga Nwankwo worked with Professor Siegel, and

Dr. Wlodzimierz Tulczyjew (Summer and September) worked with Professor Stachel.

## F) Financial Matters.

A number of financial problems have not been resolved.

1) During the past six years the Department budget for supplies and equipment has remained constant. As a result, we have customarily run at a deficit but always with substantial irritation and at no time as the deficit reflected the actual rate of increase in numbers of students and hence in needs. During 1966-67, the allocation of funds from the Graduate School for Department research and graduate administrative needs make it possible to relieve the CIA supplies and equipment budget somewhat, but it still is a substantial error in my opinion and a false economy to set the annual budget for teaching equipment and supplies in the manner just described.

2) The funds available for purchase of journals and books are grossly inadequate for a department with active research interests and a full doctorate program. This statement accurately reflects the situation with respect to current publications. When one adds to this the accumulated inadequacies of many decades, one is confronted with a physics research library which ought to have a quite major fund to remedy its deficiencies. There appears to be no such fund available in the near future. The library situation is further complicated by the lack of a professionally equipped and spacious storage and reading area. No doubt this will be rectified in a new building, although in that case I am apprehensive about preserving the autonomous nature of our physics collection when it becomes part of a general science library, as is proposed. Professor Papagiannis has sketched a general science library which can preserve the advantages of separate subject-matter libraries within such a general collection. Meanwhile, the "temporary" physics library room has been supplemented by a reading room which was constructed during June and July 1967, by conversion of half of the electronics course laboratory.

3) This naturally leads to noting the enormous pressure upon room space in our present building. We have a crisis in the lack of offices for

## Financial Matters Continued.

regular faculty members and post-doctoral research associates. In the latter connection, it seems strange that the substantial overhead which research grants pay to the University has not made it possible for additional working rooms to be made available at least to these research associates.

4) I have mentioned above the additional crisis we face with respect to the stipends offered to entering graduate students as teaching fellowships.

5) During the year, regular staff members have been put more closely under the control of the Personnel Department than was previously the case. Although little can be said by way of description of the result, this year's Annual Report must note that it has been a most difficult task for the Chairman, and the Acting Chairman, to achieve what has appeared to us to be an equitable and encouraging salary schedule for staff members. In several cases, salary increases have been utterly refused and in others they have been minimal. Establishment of so-called job descriptions has also been difficult, and together with this we don't feel assured of satisfactory recruitment when jobs become open. I feel that this particular administrative problem should be settled and without further irritation or delay, and with the primary criterion of assuring satisfactory and efficient maintenance of our educational and research functions. The latter can only be judged by the professional teaching and research faculty together with the Chairman and the relevant Deans, or so it seems to me; where there is a conflict of judgment between the Personnel officers of the University and the responsible academic staff, as has occurred this year, we are confronted by an impasse.

6) After six years Mrs. Estelle Mosher resigned her position. She has been a center in humane as well as technical meaning for the life of this Department. She left during the Summer when not all faculty and students were here, and I wish to record our general appreciation and affection for her.

## Financial Matters Continued.

7) Among the many problems connected with providing funds for research, three must be mentioned briefly here. First, the normal granting agencies have sharply curtailed their sponsorship of new projects, and they have been under severe pressure to reduce their continued sponsorship of existing projects. Second, the vastly increased rate of overhead on University research grants and contracts has meant a particular burden upon theorists, since their funds are almost entirely devoted to salaries (and the overhead rate is calculated upon the salaries, excluding therefore those portions of grants which are devoted to supplies, equipment, etc.); and so our major theoretical research grants have suffered an increased diversion of total funds available from 20% several years ago to the present rate of 56% -- at a time of no increase of overall funds available, and for most of these grants, a tendency towards decrease. Third, the general increase in research productivity has meant not only that funds should be provided for the research itself, but also for its publication, including the purchase of reprints of papers; the latter alone amounts to some \$2,000 per year.

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