Curriculum Vitae: Dr. Reva Kay Williams

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Work:

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Postdoctoral Research Affiliation:

University of Florida
Department of Astronomy
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Personal Data:

Birthplace: Memphis, TN, reared in Chicago, IL
Nationality/Gender: Black American/Female

Academic Data:

A.A. (Liberal Arts), Malcolm X Jr. College, Chicago, Illinois, 1977.
B.A. (Astronomy and Physics), Northwestern University, Evanston, Illinois, 1980.
M.A. (Astrophysics), Indiana University, Bloomington, 1990.
Ph.D. (Astrophysics), Indiana University, Bloomington, December 1991.

Awards:

John Yeatman Award: Malcolm X Jr. College, 1976.

Graduate of the Year Award: Malcolm X Jr. College, 1977.

Northwestern University Minority Fellowship, 1977-1980.

CIC Minority Graduate Fellowship: Indiana University, 1982.

Doctoral Student Grant-In-Aid of Research Award: Indiana University, 1990.

National Research Council Ford Foundation Postdoctoral Fellowship Award: $30,000; University of Florida, 1993-1994.

National Science Foundation Extragalactic Astronomy & Cosmology Planning Grant Award: $17,000; University of Florida, 1995.

Belle Ringer Image Role Model Award: Bennett College, 1998.

American Astronomical Society Small Research Grant Award: $2,500; Bennett College, 1999.

National Science Foundation Extragalactic Astronomy & Cosmology Grant Award: $7,000; Bennett College, National Radio Astronomy Observatory (NRAO) Very Large Array (VLA), and the Aspen Center for Physics, summer 2000.

American Astronomical Society Small Research Grant Award: $2,500; City College, 2006.

National Science Foundation Extragalactic Astronomy & Cosmology Grant Award: $118,725; University of Toledo, 2009.

Experience:

Teaching:

Associate Instructor, Indiana University, Bloomington, IN:
A100 *The Solar System*; summer 1982; summer 1983.
A110 *General Astronomy*; summer 1984; summer 1985.

Assistant Instructor, Indiana University, Bloomington, IN:
M118 *Finite Mathematics*; fall 1985.

Visiting Assistant Professor, North Carolina A&T State University, Greensboro, NC:
Physics 101 *Introductory Astronomy*; spring, fall 1997.
Physics 600 *Classical Mechanics* (Graduate); spring, fall 1997.
Physics 630 *Statistical Mechanics* (Graduate); spring 1998.

Adjunct Assistant Professor, City College, Gainesville, FL; fall 2003 - summer 2006:

College Algebra, Topics in College Mathematics, Statistics, Research Methods, Business Mathematics.

Adjunct Assistant Professor, Santa Fe Community College, Gainesville, FL:
AST 1002 *Introduction to Astronomy*; summer 2006.

Visiting Assistant Professor, University of Toledo, Toledo, OH:
ASTR 1010 *Survey of Astronomy*; fall 2006; spring 2007; summer 2007; spring 2008; summer 2008; fall 2008; spring 2009.
ASTR 2330 *Black Holes and General Relativity*, fall 2007.
NASC 1100 *Matter and Energy*, fall 2007; fall 2008.

Practical and Technical:

Planetarium Lecturer, Dept. of Astronomy, Indiana University, Bloomington, IN; 1980-81.

Consisted of performing planetarium shows for kindergarten to twelfth grade students and general public.

Observing Techniques, Dept. of Astronomy, Indiana University, Bloomington, IN; 1980-91:

- Graduate course taken: *Principles and Techniques of Observational Astronomy*: Principle and techniques of astronomical data acquisition and reduction. Practical experience in photography, photoelectric photometry, spectroscopy, and astronomical application of electronic detectors.

- 12 inch refractor telescope in Kirkwood Observatory: used in the graduate level observing course described above, and weekly public open house viewing.

- Solar telescope in Kirkwood Observatory: used in introductory astronomy courses, public open house, and in the special event of a solar eclipse.

- NRAO VLA radio telescope in Socorro, New Mexico: Theoretical study of radio images of Active Galactic Nuclei (AGNs) and radio astrophysical jets; December 1990.

Research:

Research Assistant, Minor Planet Center, Dept. of Astronomy, Indiana University, Bloomington, IN; 1980-81.

Research Associate, Dept. of Astronomy, Indiana University, Bloomington, IN; 1984-1991.

Postdoctoral Associate, Dept. of Astronomy, Indiana University, Bloomington, IN; 1992-93.

Postdoctoral Fellow, Dept. of Astronomy and Dept. of Physics, University of Florida, Gainesville, FL; 1993-1994.

Postdoctoral Associate, Dept. of Astronomy and Dept. of Physics, University of Florida, Gainesville, FL; 1994-1996.

Assistant Research Scientist, Dept. of Astronomy, University of Florida, Gainesville, FL, 1997-October 2004.

Visiting Assistant Professor of Physics, Dept. of Physics, North Carolina A&T State University, Greensboro, NC; Spring 1997-Spring 1998.

Associate Professor of Astrophysics and Director, Center for Women and Science, Dept. of Mathematics and Computer Science, Bennett College, Greensboro, NC; 1998-2001.

Visiting Assistant Professor of Physics and Astronomy, Dept. of Physics and Astronomy, University of Toledo, Toledo, OH; Fall 2006-2009.

Research Assistant Professor of Astrophysics, Dept. of Physics and Astronomy, University of Toledo, Toledo, OH; Fall 2008-present (affiliate).

Invited Presentations:

- **Colloquium Speaker,** " Astrophysical Black Holes and How Energy-Momentum is Extracted," Department of Physics and Astronomy, Valparaiso University, Oct 2022.
- **Keynote Speaker**, "From Supermassive Stars to Quasars: Production of Stardust: The Seeds of Life in the Universe, "Astrobiology Science Conference, Atlanta, GA, May 2022.
- **Guest Speaker,** "The Origin of the Universe: In the Beginning ... ," Aquarian Women's Leadership Society, RA MA Institute for Applied Yogic Science & Technology, May 2021.
- **Colloquium Speaker,** " Extracting X-rays, γ-rays, and Relativistic e- e+ Pairs from Supermassive Kerr Black Holes Using the Penrose Mechanism," Department of Astronomy, Indiana University, April 2021.
- **Colloquium Speaker,** " Extracting X-rays, γ-rays, and Relativistic e- e+ Pairs from Supermassive Kerr Black Holes Using the Penrose Mechanism," Center for Astrophysics | Harvard & Smithsonian, March 2021.
- **Guest Speaker,** "Extracting X-rays, Gamma-rays, and e-e+ Pairs from the Ergosphere of Rotating Black Holes Using Penrose Scattering Processes," Annual Meeting of the Ohio-Regional Section of the American Physical Society at The University of Toledo, September 28-29, 2018, Toledo, OH.
- **Colloquium Speaker**, "Extracting Energy-Momentum from Rotating Black Holes Using the Penrose Mechanism," Department of Physics and Astronomy, University of Toledo, October 2012.
- **Guest Speaker**, paper presentation, "Astrophysical Black Holes and How Energy is Extracted," at the Research Experience for Undergraduates, Department of Physics and Astronomy, University of Toledo, July 2009, 2010, 2011, 2013.
- **Colloquium Speaker**, "High Energy-Momentum Extraction from Rotating Black Holes Using the Penrose Mechanism," Department of Physics and Astronomy, University of Toledo, April 2008.
- **Seminar Speaker**, "Extracting Collimated Energy-Momentum from Rotating Black Holes Using the Penrose Mechanism," Department of Physics, University of Michigan, April 2005.
- **Workshop Speaker**, "Gravitomagnetic Field and Penrose Scattering Processes," Nonlinear Dynamics in Astronomy and Physics, at University of Florida, November 2004.
- **Colloquium Speaker**, "Collimated Energy-Momentum Extraction from Black Holes in Quasars and Microquasars," Department of Astronomy, University of Florida, November 2002.
- **Guest Speaker**, "The Origin of the Universe: In the Beginning ... ," Malcolm X College, May 2001.
- **Keynote Speaker**, Malcolm X College, 32nd Commencement Exercises, Chicago, IL, May 2001.
- **Guest Speaker,** Parallel Session, "Collimated Energy-Momentum Extraction from Rotating Black Holes in Quasars and Microquasars," 20th Texas Symposium on Relativistic Astrophysics, held in Austin, TX, December 2000.
- **Colloquium Speaker**, "Extracting Energy From a Black Hole Using the Penrose Mechanism," the Very Large Array (VLA), Socorro, NM, 2000.
- **Workshop Speaker,** "Jet Collimation in Rotating Black Holes," at the Aspen Center for Physics, Aspen, CO, June 6-25, 2000.

- **Guest Speaker,** paper presentation, "Extracting Energy-Momentum from Supermassive Rotating Black Holes Using the Penrose Mechanism," 66th Annual Meeting of the Southeastern Section of the American Physical Society, November 7-9, 1999, Chapel Hill, NC.
- **Guest Speaker,** "The Origin of the Universe: In the Beginning ... ," Bennett College, 1998 .
- **Guest Speaker,** Parallel Session, "The Penrose Mechanism and the Gravitomagnetic Field," The 8th Marcel Grossmann Meeting, held at The Hebrew University, Jerusalem, Israel, 1997.
- **Colloquium Speaker**, "Are One-sided Jets of Active Galactic Nuclei Intrinsic or Optical Illusions?" North Carolina A&T State University, 1996.
- **Participant**, poster paper presentation, "The Penrose Mechanism and the Gravitomagnetic Field," 18th Texas Symposium on Relativistic Astrophysics, held in Chicago, IL, 1996.
- **Guest Speaker**, "Are One-sided Jets of Active Galactic Nuclei Intrinsic or Optical Illusions?" National Society of Black Physicists Conference, Fisk University, 1996.
- **Colloquium Speaker**, "The Penrose Mechanism and the Gravitomagnetic Field," Department of Astronomy, University of Florida, 1996.
- **Colloquium Speaker**, "Are One-sided Jets of Active Galactic Nuclei Intrinsic or Optical Ulusions?" Department of Physics, University of Florida, 1995.
- Colloquium Speaker, "Extracting High Energy Particles from Supermassive Kerr Black Holes Using the Penrose Mechanism," Department of Astronomy, University of Florida, 1993.
- Participant, poster paper presentation, "Extracting X-rays, Gamma-rays, and Relativistic e- e+ Pairs from Supermassive Kerr Black Holes Using the Penrose Mechanism," 16th Texas Symposium on Relativistic Astrophysics, 1992.
- Colloquium Speaker, "The Penrose Mechanism," Department of Astronomy, Indiana University, 1991.

Publications:

Refereed:

1. Williams, R. K., "Collimated Escaping Vortical Polar $e^- e^+$ Jets Intrinsically Produced by Rotating Black Holes and Penrose Processes," *The Astrophysical Journal*, **611**, 952-963 (2004).
2. Williams, R. K., "Extracting X-rays, γ-rays, and Relativistic $e^- e^+$ Pairs from Supermassive Kerr Black Holes Using the Penrose Mechanism," *Physical Review D*, **51**, No. 10, 5387- 5427 (1995).

Preprints:

3. Williams, R. K., "Evolution of the Primordial Magnetic Field in an Expanding and Rotating Universe," 2011, submitted to *The Astrophysical Journal Letters.*
4. Williams, R. K., "Could Dark Energy be a Manifestation of Gravity," 2011, submitted to MNRAS; 2014, 2018, submitted to *Physical Review D,* http:// arxiv.org/abs/1109.5652.
5. Williams, R. K., "Production of the High Energy-Momentum Spectra of Quasars 3C 279 and 3C 273 Using the Penrose Mechanism," 1995, 1999, submitted to *The Astrophysical Journal,* http://arxiv.org/abs/astro-ph/0306135.
6. Williams, R. K., "The Gravitomagnetic Field and Penrose Processes," 1996, 1999, submitted to *Physical Review D*, http://arxiv.org/abs/astro-ph/0203421.
7. Williams, R. K., "New Energy Source Controlled by Gravity Alone?" 2002, submitted to *The Astrophysical Journal*, http://arxiv.org/abs/astro-ph/0210139.

Proceedings:

8. Williams, R. K., "The Gravitomagnetic Field and Penrose Scattering Processes," *Ann. N.Y. Acad. Sci.*, **1045**, 232-245 (2005).
9. Williams, R. K., "Collimated Energy-Momentum Extraction from Rotating Black Holes in Quasars and Microquasars Using the Penrose Mechanism," in Relativistic Astrophysics: 20th Texas Symposium, Austin, Texas, 10-15 December 2000 (eds. Wheeler, J. C. & Martel, H.) 448-453 (American Institute of Physics, New York, 2001), http://arxiv.org/abs/astro-ph/0111161 .
10. Williams, R. K., "Penrose Processes and the Gravitomagnetic Field," in The 8th Marcel Grossmann Meeting On Recent Developments in Theoretical and Experimental General Relativity, Gravitation, and Relativistic Field Theories, Proceedings of The 8th Marcel Grossmann Meeting, held at The Hebrew University, Jerusalem, Israel, 22-27 June 1997 (eds. Piran, T. \& Ruffini R.) 416418 (World Scientific, Singapore, 1999).

11. Williams, R. K., "Extracting Energy-Momentum from Rotating Black Holes Using the Penrose Mechanism, Bulletin of the American Physical Society," 44, No. 6, 35 (1999)
12. Williams, R. K., "High Energy-Momentum Extraction from Rotating Black Holes Using the Penrose Mechanism," Bulletin of the American Astronomical Society, 31, No.5 (1999).

Papers in Progress:

13. Williams, R. K., "Extracting High Energy Particles from Near-Extreme Kerr Black Holes Using Penrose Collisional Processes near the Horizon," in preparation, to be submitted to *Physical Review Letters.*
14. Williams, R. K., "A Rotating Black Hole Energy Generation Model for Microquasar GRS 1915+105," in preparation, to be submitted to *The Astrophysical Journal.*
15. Williams, R. K., "Intrinsically Produced Jets of AGNs by the Core Black Hole Energy Source," in preparation, to be submitted to *Nature.*
16. Williams, R. K., "The Origin of Gravitational Instabilities in the Early Universe and Magnetic Fields of Stellar-Like Objects," in preparation, to be submitted to *Physical Review D.*
17. Williams, R. K., "Vortical Trajectories in the Kerr Metric Produced by Penrose Processes," in preparation, to be submitted to *Classical and Quantum Gravity.*
18. Williams, R. K., "An Astrophysical Kerr Black Hole Model for Gamma-Ray Bursts," in preparation, to be submitted to *The Astrophysical Journal.*
19. Williams, R. K., "The Formation of Supermassive Stars in the Early Universe," in preparation, to be submitted to *The Astrophysical Journal.*
20. Williams, R. K., "An Astrophysical Model for the So-Called Dark Matter in the Universe," in preparation, to be submitted to *The Astrophysical Journal.*
21. Williams, R. K. and Eilek, J. A., "Proton-Proton Scattering and Neutral Pion Decay Penrose Processes in the Ergosphere of a Kerr Black Hole," in preparation.
22. Williams, R. K., "Evolution of Penrose Particle Processes in Kerr Metric: Gravitomagnetic and Electromagnetic Jet Collimation," in preparation, to be submitted to *The Astrophysical Journal.*
23. Williams, R. K., "On Penrose N-Particle Processes and Emissivity Profile of Seyfert 1 Galaxy MCG---6-30-15," in preparation, to be submitted to *The Astrophysical Journal.*

References:

Graduate advisors:

Dr. Richard H. Durisen
Indiana University
Dept. of Astronomy
Bloomington, IN 47405

Dr. Stuart L. Mufson
Indiana University
Dept. of Astronomy
Bloomington, IN 47405

Dr. Jean A. Eilek
New Mexico Inst. of Mining and Tech.
Dept. of Physics
Socorro, NM 87801

Post-graduate associates:

Dr. Henry Kandrup
(Postdoctoral advisor, deceased)
University of Florida
Dept. of Astronomy
Gainesville, FL 32611-2055

Dr. Fernando de Felice
University of Padova
Dept. of Physics G. Galilei
Via Marzolo 8, I-35131 Padova Italy
+39 49 8277196

Dr. Roger Penrose
University of Oxford
Dept. of Mathematics
Oxford OX1 3LB England

Dr. Karen Bjorkman
Dean and Distinguished University Professor
College of Natural Sciences and Mathematics
University of Toledo
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Dr. Lawrence Anderson-Huang
University of Toledo
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Dr. Alvin D. Compaan
University of Toledo
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Toledo, Oh 43606-3390

Mentoring: Detrick Foster, PhD; assisted numerous elementary and high school students and undergraduates on science projects.

Below are important letters of recommendation written by my advisors and Sir Roger Penrose in support of my research endeavors, ambition, and desires; also included is an article and a press release:

INDIANA UNIVERSITY

DEPARTMENT OF
ASTRONOMY

November 27, 1996

Professor Caesar R. Jackson, Chair
Department of Physics
101 Marteena Hall
North Carolina A&T State University
Greensboro, NC 27411

Dear Professor Jackson:

I have been asked to write a Letter of Recommendation for Dr. Reva Williams who is being considered for a Visiting Professorship position at the North Carolina A&T University. I am certainly happy to do so. I have a very high regard for Reva's abilities as a teacher and researcher. I have an especially high regard for Reva's dedication and work ethic. I have not interacted closely with Reva since she left Indiana, but I will tell you what I know. For an evaluation of her most recent work, you should probably rely more heavily on the opinions of the people from the University of Florida.

I believe that Dr. Williams can be an effective, independent researcher in General Relativity, particularly in the area in which she wrote her dissertation – the production of relativistic particles in the vicinity of a rotating black hole. Her dissertation is a very fine piece of work and I am sure she will continue to expand fruitfully upon it. I have recently received a reprint of her paper that was published in *Physical Review*. I think this work, which was an extension of her dissertations research, is excellent and deserves publication in a first-rank journal like *Physical Review*. She is very highly motivated and she works enormously hard. I feel certain that she is capable of carrying on an independent research program of her own. Reva has overcome many obstacles to obtain her degree and obtain a postdoc where she is now continuing her research.

I knew Dr. Williams during her entire career at Indiana. I had her in classes; she worked for me as an T.A.; and I served as her advisor for the Masters Degree

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(this research was continued for her Ph.D.). At every step along the way I was amazed by how much she grew intellectually. When Reva arrived at Indiana from Northwestern, it was not at all clear that she had the skills required for Ph.D.-level research. But she perservered and is now carrying out an effective research program of her own. I did not serve as the Chair of her Ph.D. committee, as I did for her M.S. committee, because she outstripped my competency in General Relativity. She basically taught herself what she needed to know for her Ph.D. research since we have no relativists at Indiana. Nevertheless, she perservered and produced a first-class piece of work.

Dr. Williams worked for me as a Teaching Assistant in an elementary astronomy class several years ago. In that capacity she held office hours and she graded exams and quizzes. She performed both tasks well. Reva has also taught her own classes in elementary astronomy during summer sessions. As is common with first-time teachers, she first read and spoke into her notes. But she learned quickly and soon became an effective teacher at the elementary college level.

I strongly believe that Dr. Williams' ambition and drive will carry her far. I certainly support her for this position.

If you have any questions, please do not hesitate to call or write.

Sincerely Yours,

Stuart Mufson

Stuart Mufson, Chair
Department of Astronomy

INDIANA UNIVERSITY

DEPARTMENT OF ASTRONOMY

December 3, 1996

Dr. Caesar R. Jackson, Chairman
Department of Physics
NC A&T State University
101 Marteena Hall
Greensboro, NC 27411

Dear Dr. Jackson:

It is a pleasure and a privilege for me to recommend Dr. Reva K Williams for a position as a visiting professor in your department. I have known Reva well as a student in our graduate program through my various roles as Director of Graduate Studies, Departmental Chairman (1986-1990), teacher of a graduate course, and, most recently, Chairman of her Dissertation Research Committee. Reva was an unusual doctoral student in many respects. As an applicant for admission to our graduate program, her record at Northwestern University in astrophysicists was quite weak. However, a strong letter of support from a faculty member at Malcolm X Community College and her own passionate personal statement impelled me to recommend her for admission in the 1980-81 academic year. Women and especially Afro-Americans are underrepresented in astronomy and astrophysics, just as they are in other physical sciences. There are not many Afro-American astronomers in the United States; and, to my knowledge, counting Reva, only two or three of them are women.

Reva passed the Ph.D. Qualifying Examination in Astronomy on November 21, 1984 and completed all necessary course work by Spring, 1984. The graduate faculty in the department urged her to write a master's thesis before undertaking her doctoral research. This was not easy for Reva, in part because she was determined to define her own problem. In the process, she attended scientific meetings on her own and approached various prominent experts outside the department for advice, including Roger Penrose and nobel laureate William Fowler. Dr. Stuart Mufson, who became her master's thesis advisor, assisted Reva throughout this phase. A research topic was defined which, through successive elaborations, provided the basis for both her master's thesis and then her doctoral dissertation. After her master's defense in Fall, 1990, I took over the direction of Reva's dissertation; but, not being an expert in Reva's area of research, I asked Dr. Jean Eilek (New Mexico Institute of Mining and Technology) to co-direct Reva's work. Jean graciously agreed and soon became an invaluable and energetic participant in defining and guiding Reva's efforts. Reva successfully defended her doctoral dissertation in December, 1991.

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I am truly impressed by what Reva accomplished at Indiana University! At several stages of her graduate student career, I worried about her ability to surmount the next obstacle; but then she always did Reva has a driving will to accomplish her own goals on her own terms. She could perhaps more easily have excelled in other academic disciplines; but she was determined, well before her arrival at I.U., that she would work on frontier problems in gravitational theory and high-energy astrophysics. It took her several years to understand her research area well enough to define and complete a research problem; but what she achieved as a result is in some respects beyond the ability of many of her contemporaries who completed their degrees more quickly by plugging into ongoing faculty research projects.

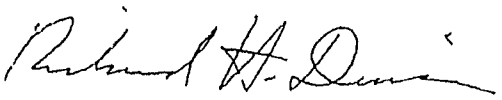
In an effort to explain the energetics powering active galactic nuclei (AGN's), Reva has computed the output spectra of photons and electron-positron pairs due to scatterings of photons which occur in the ergoregion of a massive rotating black hole. Scatterings in the ergoregion can tap the rotational energy of the black hole (the Penrose Mechanism) and can produce gamma rays and relativistic electrons from low energy photons generated in accretion structures around the hole. The origin of the relativistic electrons which give rise to synchroton radio emission from AGN's has been an unsolved problem for decades; and Gamma Ray Observatory has even detected gamma rays from a number of AGN's. Reva's dissertation demonstrated mechanisms which are plausible sources of such high-energy particles in a black hole environment. Her calculations were impressively complex. She had to perform new analyses of orbit motions near a Kerr Black Hole to generalize escape conditions for scattered particles, and she had to employ Monte Carlo techniques to connect input test photon energies with output particle energies as seen by an external observer. The calculations required a series of general and special relativistic frame transformations into and back out of an appropriate inertial frame for the scatterings. She considered Compton scattering, as well as pair production by γp and $\gamma\gamma$ interactions. Reva's dissertation showed that scatterings in the ergoregion could produce observable effects. Even if the tapping of black hole rotational energy is not important, scatterings in the ergoregion may permit a higher black hole accretion efficiency than previously estimated. The scatterings may also significantly modify the spectrum of photons and material particles emerging from the vicinity of the black hole.

Reva is bright and hardworking, with an indominable self-confidence. As should be evident from her personal history, her single most impressive traits are her extraordinary determination to succeed and her extraordinary dedication to accomplishing goals despite obstacles. I think these are qualities which are strong predictors of success in her further professional development. She is also cheerful and energetic in person and easy to interact with. Although she took our full complement of graduate courses, her mastery of astrophysics at I.U. was spotty. She could be deep in areas directly related to what she was currently doing and sometimes surprisingly weak when she ventured away from her current focus. Her learning curve is quite steep, however; and I believe she will broaden her expertise as she continues. I suspect that she has already done so during her postdoctoral years.

It has been too many years (over ten) since I have seen Reva in a classroom setting at I.U.; and so I can say little relevant to her present qualities as a teacher. However, I can say that, during her dissertation defense, she was quite relaxed and exuded a charming self-confidence and, as a result, she gave one of the best introductory presentations I have heard at a doctoral defense. Her personality is winning; and I believe that she will quickly learn to use this asset effectively in future teaching efforts and other professional interactions.

I am extremely pleased to have assisted Reva in the fulfillment of one of her dreams, namely earning a Ph.D. for original research in gravitational theory. Her current goal is to establish herself as a respected academic researcher. She already seems well on her way toward this end as a postdoctoral fellow at the University of Florida; and I am delighted that you are considering her for a visiting professorship. I recommend her very highly.

Respectfully yours,



Richard H. Durisen
Professor

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Dr. Caesar R. Jackson, Chairman
Department of Physics
NC A&T State University
Greensboro, NC 27411

10 December 1996

Letter of Recommendation for Reva K. Williams

I am writing to express my enthusiasm and support for the appointment of Reva K. Williams as a Visiting Professor at North Carolina A&T State University.

In my opinion, Dr. Williams is a creative and original thinker who, albeit still quite young professionally, appears to be maturing into a solid theoretical astrophysicist. At a time when all too many young scientists focus on small, straightforward pieces of relatively insignificant problems, Dr. Williams is attempting to explain a major unsolved puzzle in high energy astrophysics – the origin of the apparent asymmetry of jets from active galactic nuclei – using the Penrose process from classicial general relativity Specifically, she aims to exploit the presence of an ergosphere, a generic feature associated with any rotating black hole, to generate a much larger, and more one-sided, energy emission than would be possible from matter accreting onto a nonrotating black hole of comparable size

Dr. Williams came to the University of Florida after completing a Ph D. at Indiana University and has worked in my group as a postdoctoral fellow. When first she arrived in Florida, Dr. Williams was supported by a Ford Foundation Minority Fellowship. After that fellowship expired, she was supported by a short term National Science Foundation grant.

Dr. Williams is both competent and motivated, and she has manifested steady progress scientifically since arriving at the University of Florida. In her chosen field, high energy/relativistic astrophysics, she is largely self-taught, having selected a thesis area in which she could receive relatively little guidance from the faculty at Indiana. The fact that she has, nevertheless, done solid, and potentially significant, work in this area is an impressive testament to her hard work and positively fierce drive.

While at the University of Florida, Dr. Williams has presented about a half dozen seminars and colloquia, all of which were well received. Unlike many talks presented by junior scientists, these were clear, well organised, and to the point, all of which suggests to me that she has the makings of an excellent instructor

I respect Dr. Williams, both as a scientist and as an individual, and I hope very much that she will eventually secure a permanent faculty position. Upon more than one occasion, I have recommended to the University of Florida that it might hire Dr. Williams as a Lecturer or Assistant Professor; and, given a suitable opportunity, I would make this same recommendation again.

Yours sincerely,

Henry E. Kandrup
Associate Professor of Astronomy and
Affiliated Associate Professor of Physics
University of Florida
kandrup@astro.ufl.edu

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To whom it may concern

CONFIDENTIAL

Tuesday, 8 February, 2005

I understand that

Dr Reva Kay Williams

is applying for a position at your Department, and that a letter of support from me may be of value. I once met her at a conference, many years ago, when she described to me some of her ideas about using what is referred to as the "Penrose process" as a basis for the procedure whereby some of the most dramatic astrophysical actions, such as the jets of active galaxies, might come about via the harnessing of the rotational energy of a central black hole. At that time, I was not much acquainted with the conventional procedures that had been suggested, and though I was very intrigued by Reva's ideas, I did not think much more about them at the time. However, about a year ago, I became re-acquainted with her work, as it has developed since then, and also with some of the opposition that she had run into in earlier years.

I should explain that I am no expert in astrophysics, and have not made a comparative study of proposals for energy extraction from black holes in realistic astrophysical situations. I am, however, familiar with many of the theoretical issues that come about in relation to black holes. From this, one thing seems to me to be reasonably clear, namely that if it is proposed that some process harnesses a black hole's rotational energy, then something of the general nature of a "Penrose process" *must* be involved. The essential point is that with a black hole, there is "nothing to hold on to" in the ordinary way, there being no considerable surface, and the rotational energy has to be extracted basically by means of the black hole swallowing some form of matter (or fields) that has *negative energy* with respect to a frame fixed at infinity. This is precisely what constitutes a "Penrose process" in its most general form.

It was therefore a surprise to me to find that Reva had encountered such opposition in the early days of her research, since she was making this explicit in her own proposals for black-hole energy extraction, whereas in the more fashionable (e.g. Blandford-Znajek) types of proposal, there had not seemed to be an early appreciation that this kind of thing must be an essential ingredient. True, Reva's proposals were basically particle-based, whereas in the more fashionable ideas, energy extraction is to occur via electromagnetic fields. I am in no position to judge between these two kinds of proposal, but it seems to me that Reva had more clearly understood the essentials of black-hole energy-extraction processes.

Accordingly, I have formed a high opinion of her insights and recommend her most strongly.

Yours faithfully,

Roger Penrose

Young Scientist May Be First to Prove Theory on Black Holes

Many scientists spend a lifetime trying to make a significant contribution to their field of study. Reva Kay Williams, on the other hand, may be recognized for possibly solving a major astronomical theory before she even finished graduate school.

Reva Kay Williams, who is doing post-doctoral work at UF and lecturing for the Department of Astronomy, may be the first to prove an important theory on black holes. After receiving her doctorate from Indiana University, Williams came to UF on the Ford Minority Fellowship to continue her research.

"I always wanted to do something big in astronomy," said Williams, who is doing post-doctoral work at the University of Florida and lecturing for the Department of Astronomy. "Now I have a model that attempts to explain many things about quasars that were once thought to be a mystery."

After five years of work, Williams proved the Penrose mechanism — a theory which explains how to extract energy from a black hole. (Black holes are the result of "burned out" stars where strong gravitational forces prevent anything from escaping, including light.)

She created a computerized version of her model which attempts to explain two things: how to capture energy from black holes and how black holes are responsible for giving quasars their energy. (Quasars are the most distant objects in the universe and have the greatest energy output of any object.)

"I knew that quasars were a mystery and that people were trying to explain their energy source," she said. "So I decided to research this as part of my dissertation."

Williams said many of the faculty at Indiana University — where she received her doctorate — questioned her decision to try something so difficult.

"I had a lot of feedback from professors asking me why I wanted to do this," she said. "So I didn't start immediately trying to prove the Penrose mechanism. I tried working on different models at first, but I ran into the same problems that other researchers had run into. The Penrose mechanism was my last resort."

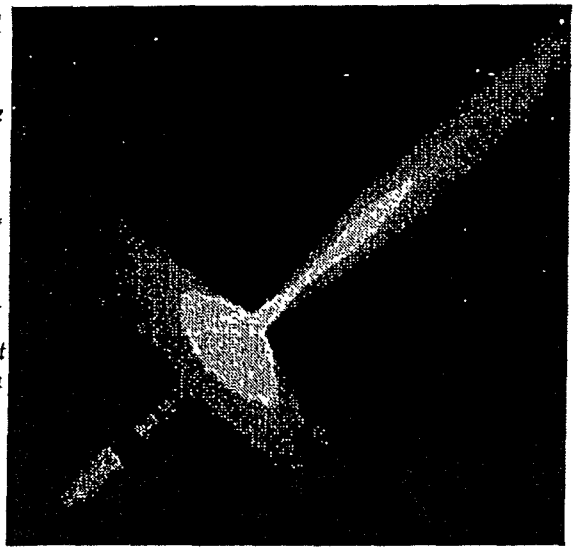
Not only has Williams apparently proved the Penrose mechanism, but she has also personally handed her solution to Roger Penrose himself — a renowned professor of mathematics and physics at Oxford University in England.

"He smiled and said that he was pleased," she said. "I'm now in the process of writing him a letter explaining my results."

Her paper was published in the May 1995 *Physical Review Journal*, a leading physics journal. Because of its length, Williams is concerned that many of her colleagues may not have read it, and consequently are unaware of her accomplishment.

"As of right now, I'm still trying to sell my idea," she said. "Since it's a big paper, I'm writing four-page letters, or short papers, to let people know what I've done and to direct them to the larger paper."

Williams came to UF on the Ford Foundation Minority Fellowship and is continuing her research on black holes and quasars, while also studying cosmology and gravitation forces in the early universe.



Radio jets associated with galaxies and quasars — the most distant objects in the universe — are powered by material falling into a massive, spinning black hole. Williams' model attempts to explain quasars' unusual one-sided jet distributions, as seen in this illustration. (Picture courtesy of Realm of the Universe, 5th edition.)

ASTROPHYSICIST HELPS CRACK A BLACK HOLE MYSTERY: ENERGY JETS

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Contact Information

GAINESVILLE, Fla. --- With almost limitless gravitational power, black holes are supposed to gulp everything that comes near them, even weightless light photons

So astronomers have long sought explanations for observations that black holes emit high-energy particles, often through visually impressive jets that unfurl from the black holes' poles in thick, tornado-like coils. Now, in a paper published in this month's edition of the Astrophysical Journal, a University of Florida researcher has bolstered and expanded a longtime theory about how and why these photons and electrons escape powerful gape of black holes, caused by the collapse of stars

"My calculations may solve the mystery as to where the large number of high-energy observed electrons originate from," said Reva Kay Williams, a UF courtesy postdoctoral associate. "My calculations also help explain some of our observations, such as why many (black hole) jets are observed to be uneven, or one-sided."

Williams' research is the first to prove the Penrose mechanism, a 35-year-old theory named for its author, Oxford University mathematics and physics professor Roger Penrose. It also provides a new, physical explanation for the odd appearance of many of the jets, which some astronomers believe was merely the result of an optical illusion.

Fernando de Felice, a physicist at the University of Padova in Italy, said Williams' findings represent an important contribution to the field

"Until recently, it was believed that the Penrose mechanism was not very efficient for generating energetic particles, but Dr Williams' detailed and perseverant work showed that this may not be true and, to the contrary, that it may be relevant to high-energy astrophysics," he said.

Penrose's theory says the rotational energy of a spinning black hole powers and lifts particles large distances away. Williams' research, based in part on computer modeling, shows these particles appear to be created at the part of the hole where gravity is so powerful it bends light into a circle around the hole

Her calculations also suggest the one-sided appearance of the jets is the result of the black holes' gravitational dragging of space and time near their cores - not just, as some suggested, a consequence of the observer's position relative to the jets "The interest in Dr. Williams' work is that it has enriched the possibilities of having energy output in active cosmic sources," de Felice said

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