# Curriculum Vitae: Dr. Reva Kay Williams

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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-present.

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

## Invited Presentations:

- **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, "**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 Illusions?" 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, -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," submitted to *The Astrophysical Journal Letters.*
4. Williams, R. K., "Could Dark Energy be a Manifestation of Gravity," 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," submitted to *The Astrophysical Journal*, http://xxx.lanl.gov/abs/astro-ph/0306135 .
6. Williams, R. K., "The Gravitomagnetic Field and Penrose Processes," submitted to *Physical Review D*, http://xxx.lanl.gov/abs/astro-ph/0203421 .
7. Williams, R. K., "New Energy Source Controlled by Gravity Alone?" submitted to *The Astrophysical Journal*, http://xxx.lanl.gov/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://xxx.lanl.gov/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.) 416-418 (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., "A Rotating Black Hole Energy Generation Model for Microquasar GRS 1915+105," in preparation, to be submitted to *The Astrophysical Journal*.
14. Williams, R. K., "Intrinsically Produced Jets of AGNs by the Core Black Hole Energy Source," in preparation, to be submitted to *Nature*.
15. 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*.
16. Williams, R. K., "Vortical Trajectories in the Kerr Metric Produced by Penrose Processes," in preparation, to be submitted to *Classical and Quantum Gravity*.
17. Williams, R. K., "An Astrophysical Kerr Black Hole Model for Gamma-Ray Bursts," in preparation, to be submitted to *The Astrophysical Journal*.
18. Williams, R. K., "The Formation of Supermassive Stars in the Early Universe," in preparation, to be submitted to *The Astrophysical Journal*.
19. Williams, R. K., "An Astrophysical Model for the So-Called Dark Matter in the Universe," in preparation, to be submitted to *The Astrophysical Journal*.
20. 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.
21. 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*.
22. 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
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Dr. Roger Penrose
University of Oxford
Dept. of Mathematics
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Dr. Karen Bjorkman
Dean and Distinguished University Professor
College of Natural Sciences and Mathematics
University of Toledo

Dr. Lawrence Anderson-Huang, Chair
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Dr. Alvin D. Compaan
University of Toledo
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## Summary of Research Activities

I am presently a Research Assistant Professor of Astrophysics (2008-present) at The University of Toledo (UT). I am a former Visiting Assistant Professor of Physics and Astronomy (2006-2008) and formerly an Associate Professor of Astrophysics and Director of the Center for Women and Science at Bennett College (1998-2001). I was previously (beginning in January 1997) a Visiting Assistant Professor of Physics at North Carolina A&T State University. I am formerly an Assistant Scientist at University of Florida (1997-2004), collaborating with Dr. Henry Kandrup, my postdoctoral advisor. I was a Ford Foundation Postdoctoral Fellow and Postdoctoral Associate at University of Florida (1993-1996). My research interests are relativistic astrophysics, general relativity, cosmology, and extragalactic astronomy. I am an independent, diligent, and very devoted worker. I am a dynamic speaker, and have the talent of conveying very difficult subject matters to any audience's level of understanding. This talent has made me a dynamic lecturer also, as pointed out by students—on instructor evaluation forms—and colleagues.

My past, current, and planned research activities involve theoretical (i.e, analytical) and numerical studies of the following:

### (1) Energy Source of Active Galactic Nuclei

The structural components of the energy source of quasars and other active galactic nuclei (AGNs) are studied. The energy source is modeled using Penrose scattering processes [Williams 1995 (see publication list)], which result in the emission of intrinsically collimated highly energetic particles escaping from the rotating black hole near the event horizon (Williams 2004), powering the astrophysical jets, and producing relativistic beaming and electrodynamics [i.e., magnetohydrodynamics (MHD)]. The next project in this area of study is to investigate the electrodynamics of the escaping Penrose produced $e^+$ $e^-$ pairs. The effects of this intrinsic electrodynamic field, associated with the escaping pairs, and that of the accretion disk will be compared to see which field (if not both) is important in powering the jets out to observed distances. It appears that I will need access to a supercomputer to perform some of the numerical aspects of the analytical equations. I hope to collaborate with some other scientist(s) versed in MHD numerical calculations. Note, my present research assistant professorship at University of Toledo allows me access to a supercomputer; I plan to begin this project in the coming months.

### (2) Gravitational Instabilities in the Early Universe and Galaxy Formation

The origin of gravitational instabilities and the formation of galaxies in the early universe are investigated. Electromagnetic and gravitational interactions are employed in modeling gravitational instabilities (that perhaps assist those due to quantum fluctuations) and formation of supermassive stars as protogalaxies. I began working diligently on this project while a postdoctoral fellow at University of Florida (UF) in1994. I made several

exciting discoveries in my analytical derivations and calculations, and was in the process of writing up my results, when I was forced to leave UF to take a visiting assistant professorship appointment at North Carolina A&T State University in January of 1997. This career move was made because I was not getting paid a salary at UF, required for livelihood, after funds from my postdoctoral fellowship were depleted. Upon arriving at North Carolina A&T and subsequently Bennett College, teaching and administration duties did not allow me sufficient time to work on this research project. Nevertheless, I have most recently resumed this research, and I am very much excited about completing this project in the near future, which I expect will bring us closer to an understanding of a still poorly understood branch of astrophysics.

**(3) The Nature of Dark Matter**

The nature of dark matter is investigated in which gravitational and electromagnetic particle quantum-like interactions are used to model the so-called dark matter. This concept is similar in character to the particle physicists' dark matter hypothesis (proposing exotic elementary massive particles that interact weakly with radiation called WIMPs), yet different. I began this project also as a postdoctoral associate, and, again, due to employment involving more teaching and less research, time has not permitted me to complete and publish results. Nevertheless, when I proposed this investigation in a grant proposal to the National Science Foundation (NSF) in 1995, I was encouraged by the panel to continue this investigation. Similar encouragement came from my postdoctoral advisor, the late Dr. Henry Kandrup, relativistic astrophysicist. I believe that completion of this project will bring us closer to understanding of what constitutes so-called dark matter.

**(4) Black Holes to Power Gamma-Ray Bursts**

The nature of gamma ray bursts is studied in which models of collapsing massive stars to black holes and semi-active somewhat isolated black holes, "turn on," by way of infalling matter, resulting in Penrose processes, which emit polar astrophysical jets of radiation. Rotating black holes are objects that can "radiate" the necessary powers (or luminosities) comparable to γ-ray bursts. I will investigate what are the conditions needed in order for black holes to explain at least some of the observed γ-ray bursts. This was a project I proposed for funding to NSF in 1995, then again in 1999. I believe that I was the first to propose that γ-ray bursts might be beamed radiation from a black hole. However, prior to the above stated years observations were not available, as they are today, which strongly suggest that radiation from γ-ray bursts is beamed and rotating black holes appear to explain at least some γ-ray bursts.

**(5) Energy Source of Microquasars**

"Microquasars" are investigated in which scaled down models of AGNs, as described in item 1, are used to model these stellar-sized black holes. I collaborated somewhat with

the late noted radio astronomer Dr. Robert M. Hjellming, of the NRAO VLA, on this research project. I desire to finish up the paper that we were working on together. We began writing this paper in January 2000. We collaborated up until his untimely passing in July 2000. Nevertheless, with very little time to complete this paper due to teaching and administrative obligations, I did manage, however, to continue writing and collecting new observations. At near completion of this paper, while in the process of making final graphs of specific results, in November 2004, the chair of the Department of Astronomy at UF terminated my use of research facilities, which included use of the Departmental computer UNIX operating system that I was using to graph and run my programs. This termination halted research activities on this paper for many years. An update to this research project is that my present research assistant professorship at University of Toledo provides me with the necessary research facilities to complete this paper. I expect this paper to be completed in the coming months. Upon completion of this paper I plan to submit it to *The Astrophysical Journal*.

**(6) The Nature of Dark Energy**

The nature of dark energy is investigated as possibly being explained by the gravitation field associated with a rotating Universe [i.e., the "gravitomagnetic (GM)" field]. There exists some anomaly in the cosmic background radiation that could indicate the Universe is rotating. I investigate what rotational properties are needed to have a nonnegligible repulsive GM force component in the radial direction. The GM field of a rotating black hole using the Kerr metric is investigated in Williams (2004, 2002). To investigate the GM field of the Universe, a metric is used that describes the spacetime separation between cosmic events in a rotating an expanding Universe, derived from Einstein's field equations. Such repulsive radially directed GM force would be exerted on moving sources of cosmic rotation, affecting the cosmic scale factor. I investigate whether or not such GM force, which produces acceleration, is consistent with the measured cosmic acceleration due to so-called dark energy.

Note, in the above research projects, I desire to involve students on the graduate and undergraduate level, and, eventually, postdoctoral associates.

Moreover, my successful classic theoretical computation of a model to extract energy from a Kerr black hole (Williams 1995, Phys. Rev., **51**, No. 10, 5387-5427) has contributed greatly to the study of quasars and other AGNs. This model also allows us to identify any size black hole observationally. It must be stressed here that I am the first person to successfully work out the Penrose mechanism (proposed in 1969 by Professor of Mathematics Roger Penrose, Oxford University), and thus, create a model to extract energy from a black hole, i.e., a model that attains energy-momentum values consistent with objects believed to be powered by black holes, in particular quasars. Since the 1994 confirmation by NASA's Hubble Space Telescope that black holes exist in nature, my work has become increasingly popular (see Wikipedia: The Free Encyclopedia under *Frame-dragging*, *Gravitomagnetism*, and *Polar*/*Relativistic jet*, which features/references

my work and papers).

Besides being recognized as the United States' first Black female astrophysicist (http://www.math.buffalo.edu/mad/physics/williams_reva.html), I am considered an expert in the study of black hole physics: my knowledge has been drawn upon to referee papers considered for publication by *Physical Review* journals and Kluwer Academic Publishers; and to review grant proposals for NSF-Astronomical Division.

Importantly, I returned to University of Florida in summer 2002 to improve my publication productivity, in an environment I believed to be conducive to my research, with prospects of landing a faculty appointment after meeting with the Dean of the College of Liberal Arts and Sciences. However, the Chairman of the Department of Astronomy prevented such appointment stating that he did not want the department taken into the direction of my research, relativistic astrophysics. Subsequently, with the untimely passing of my postdoctoral advisor Dr. Kandrup, in November 2003, the only other relativist in the Department, the Chairman terminated my courtesy appointment in November 2004, preventing me from using Departmental research facilities, including computers, printer, etc., and deleted my Astronomy Departmental computer account, storing my work on a computer disc. This was a relatively minor setback on the road to improving my publication record, since I had recently published a paper in the Astrophysical Journal (August 2004) and had another submitted paper to this same journal, going through the peer reviewing stages: the minor setback being that I was using some Departmental software to run my programs and to graph my results. Nevertheless, because I had a laptop with a LINUX operating system, purchased with a National Science Foundation grant, I spent time from November 2004 to the time of an unfortunate apartment-complex fire, occurring March 2005, adjusting my computations to run programs, and graph results, on my PC. But after the fire that destroyed my PC, I did not have access to a computer at all to continue my research, save reading journal papers on the Internet. This, however, of not being able to effectively do my research, was a major setback!

After eight months without a PC, I was given the opportunity to lease a Dell Inspiron 2200 laptop, equipped with Windows XP operating system (rent to own), which I subsequently purchased with an AAS Small Research Grant (2006). This PC and my present appointment at University of Toledo have allowed me to resume my research activities, which I expect will lead to publications, and, importantly, have given me the opportunity to teach physics and astronomy courses. My desire is to continue to improve my publication record, so that I may acquire a tenure-track faculty position at a research and teaching institution, allowing me to share my knowledge with students and with colleagues in my profession and scientific field of study.

In conclusion, unfortunately, due to circumstances beyond my control, I have not had the career opportunity to obtain a permanent faculty position at an institution where I can teach and do research at the level of my capability. This has made my research capability

appear to be below my peers who were fortunate to secure such faculty positions.

## Teaching Statement

I enjoy teaching and sharing my ideas with others. Specifically, I desire to teach astrophysics and physics based courses, including general and special relativity.

I believe that teaching is a way to share one's knowledge of a subject matter with the students. Some instructors make the mistake of trying to teach the students "everything" the instructor knows about a subject. This is impossible and it results in boring lectures, with many of the students failing, dropping or withdrawing from the class. The purpose of a course textbook is to organize that knowledge to be shared with the student in a concise manner, to serve as a somewhat guideline of material to be presented and explained. I believe that the instructor should stick to the course outline and course objective.

I believe that a happy class is one that learns. Therefore, methods of teaching must be applied to make the class environment and work as fun as possible for the student. The most important way to achieve this is to make the students feel that they are a part of the learning process, i.e., get them involved with the subject matter by simply asking them questions as one lectures as opposed to the instructor giving the students all the answers. In this way the students feel that they are part of the learning process. This has the tendency to make the students want to learn more, so that they can share more.

I believe that a student's background makes a difference in how a student learns; therefore, one should teach accordingly. My experience as a student from a background very different from others in my college major area of astrophysics taught me how to teach on all levels of learning, yet achieving the same objective for all the students in a particular course, and at a particular college or university. That is, for the more advanced student say one who attended college just out of an academically privileged high school and say another student from a less privileged inner city high school, my academic learning experience enables me to teach both students achieving the same course objective. This means presenting the subject material on a level with a certain degree of assumed knowledge on the part of the student so as not to bore nor deprive the more advanced students, while, at the same time, identifying the students that need personal help to bring them up to the appropriate level. This experience arose from being an undergraduate at Northwestern University majoring in astronomy and physics. In most of my physics, astronomy, and math classes the professors assumed that the students knew a lot more before taking the course being taught than what I knew at the time. So I had to work much harder than my fellow Caucasian classmates who had been raised in an environment and attended high schools that prepared them for college courses in such majors. That is to say, with my being Black, from an inner city high school, and from a single-parent home with seven siblings, I did not have the same opportunities.

Nevertheless, my academic learning experience allows me now to be more sensitive to the individual needs of the students.

I have experience in teaching large classes (such as at Indiana University, North Carolina A&T State University, The University of Toledo) and small classes (such as at Bennett College, City College). I encourage collaboration in the class room. I encourage the students to talk amongst themselves and share ideas. However, I explain to them the importance of not just copying a classmate's work, making sure that he/she understands the workgroup's answer, and I let the students know that I am available to explain where they lack understanding.

My theoretical research in the area of astrophysics allows me to bring to the class, teaching examples of applied mathematics, physics, and astrophysics. I believe that teaching on the college level should be an intricate part of research. As a faculty member performs research projects, he or she should always keep in mind how this research may be used in the classroom.

Finally, education is all about a student learning and retaining as much from a course as possible, particularly if the course is in a student's major. I like to practice what I call "academic immediate feedback." This involves going over assignments, quizzes, and exams immediately after the students finish. That is, after the work is completed the student checks his or her answers. Of course this cannot always be accomplished in large classes in the case of exams. Nevertheless, this method gives students the opportunity to see correct answers immediately after their attempts. I think students learn better this way, and it helps them to retain the material.