Statement of research plan

My main field of research interest is non-linear experimental Optics, during the past seven years my research experience includes three-years characterizing electro-optics properties of polymer and liquid crystalline materials (including ceramics) and their applications, two-years industrials' research and engineer experience on testing and designing laser-based optical devices and several months research experience on beam propagating in biological materials. The future research plans are based on the former experience and are aimed to continue and develop experimental biophysics research program by combination my optics experience with my knowledge of biological cells.

One of the main interests is developing a laboratory experimental optical tool for the quantitative deformation of cells and this method is called the "optical stretcher". Individual biological cells can be trapped and deformed therefore stretched when the radiation pressure of two counter-propagating laser beams are applied. Using non-focused laser beams to protect the cells from damageable light intensities which is different from optical tweezers since most cells trapped with optical tweezers do not survive beam power greater than 20-250 mW depending on the specific cell type and the used wavelength. 780 nm Ti-sapphire laser will be used to minimize thermal heating of the sample from absorption. With fluorescence microscopy demonstrating the essential features of the cytoskeleton in a cell which is connected to the plasma membrane acting as a spring and building up a restoring tension, the optical stretcher can provide accurate measurements of whole deformed cell elasticity and thus can distinguish between different cells by their cytoskeletal characteristics and for the same reason it can be used for quantitive research on the cytoskeleton. Also the deforming force profile might be calculated to help in understanding the structure of cytoskeleton. Once the cell is fixed the surface and the structures and concentration of molecules in cell can be obtain by Raman spectroscopy.

A better understanding of the basic cytoskeletal cell biology from the "optical stretcher" will contrbute to the understanding of the pathology of these disorders and can impact their diagnosis and therapy. Since measuring changes in the cytoskeleton are often used to diagnose certain diseases such as cancer the "optical stretcher" could be a novel approach and by using a micro-fluidic flow chamber it could advance to a diagnostic tool in clinical laboratories. Combined with Raman spectroscopy, unhealthy cells or tissues can be detected with less invasion.

Experimental biophysics research projector can involve students in both undergraduate and graduate level. Student participation in research is an important part of the educational and research plan. In additional to learning background information of project especially for biophysics-interdisciplinary project, they learn about developing, running experiments and solving the problem. Also this is a way I prepare students for future careers.

Teaching experience/philosophy and Research interests

I consider myself one of the people who love the profession of teaching. Responsibility, perseverance and keeping the students involved in the subject in a friendly manner are my essential goals that I set for myself in the process of teaching. I also want my classroom to be a place where the students are engaged in their learning, and it is very important for me to teach science or non-science major students to apply science to a variety of disciplines and real-life problems.

TEACHING EXPERIENCE

I have a five-year full-time teaching experience in China as an assistant Professor and six-years States' part-time Graduate teaching assistant experience and two years (from August 2002) States' full-time visiting assistant professor of Physics teaching experience.

Since a graduate student at department of Physics, Florida International University, I practiced teaching, having in mind my future career.

My professional teaching career started by teaching at Elizabeth city state University as an assistant professor of Physics after two years full-time working in industrials as an Engineer or a scientist. During the past two years I taught classes in a wide range of Physics subjects, from introductory Physical science courses to advanced Modern Physics, at the undergraduate levels and my teaching also covers calculus and Electronic & circuits.

TEACHING PHILOSOPHY

Remaining energetic, positive and showing students that you are willing to work with them creates a successful learning environment. It is very important for me that my students realize that I respect them and appreciate their comments, questions or remarks regarding our lectures. That is why I think that all the lectures must be interactive. Working with students made me think that a teacher must keep a positive attitude in front of the students and a positive relation with them throughout the learning process, guiding them through difficulties and stimulating their mind for a better understanding of the subject. Clear explanations, sometimes, using a less informal style, with plenty of diagrams and figure, can help students understand better certain abstract Physical notions. Graphical method utilized in teaching and detailed data on the construction of proofs might increase students' ability if they are limited to using only a strategy of learning with which they might be less comfortable. I think that most effective teaching of Physics combines both visual and abstract techniques, and it is essential to teach students how to memorize and recall facts. To illustrate how Physics is used to solve real-life problems and to awake in students an interest in Physics where such an interest does not exist, I used examples involving Physical concepts and I taught students how to develop a systematic approach to problem solving. I spend more time on learning them how to apply the theory to practical problems, and not just to try to solve their homework without learning attentively the course. Sometimes, in my teaching, I first show students how to understand the pieces of information presented in a real life problem. Then I teach them how to translate the problem into one involving the physical concepts they have learned. In general, I encourage the students to study more individually or in small groups, and come to my office for discussing more about those problems with which they came across during the Physics lessons. All the time I help my students to guide themselves into the learning process, and not just memorize formulas, explaining them carefully that the latter way of learning might create confusions in their mind just before the examinations. Secondly, repetition is extremely important. I begin my lectures with a briefly presentation of the theory taught at the course, just to remained them the need physical notions for that class. My teaching experience also tells me that teacher's teaching enthusiasm is the key to attract students' attention.

Courses taught in USA:

Principle of Physical Science and lab (GE 152 (L)), Optics (Phys 310), Math Methods of Physics (Phys 441 & 442), Modern Physics (Phys 481 & 482), Mechanics I & Mechanics II (Phys 201 & 202), Electricity & Magnetism II (Phys 302), General Physics and lab (phys 181(L) & 182 (L)), Electrical Circuits and lab (Tcel 131 & 132), Calculus & Analytic Geometry I (Math 157), Astronomy (Ast 2100L, FIU), PHYS 1441L & PHYS1442 L & PHYS 1443L & PHYS 1444L (UT-Arlington)

Research interests:

Experimental nonlinear Optics, biophysics and materials physics: Piezoelectric materials and their application; Electro-optics properties of E-O materials (including polymer & liquid crystals & Ceramic) and their devices in Optical communication; nonlinear-optic effects on fiber-optics; computer simulations of optical systems.

STUDY OF BRAIN CELLS BY NEAR-INFRARED RAMAN SPECTROSCOPY

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Abstract: Early detection of cancer with less invasive diagnosis is still a great challenge in clinical oncology however recently Raman spectroscopy with optical tweezers has been used for cancer diagnosis. The primary objective of this work is to use Raman spectroscopy to detect spectral changes between Astrocytoma (brain cancer cell) and Astrocyte (normal brain cell). Raman spectral for both Astrocytoma and Astrocyte are analyzed and discussed.

Key Words: Raman spectroscopy, optical tweezers, brain normal cell, brain cancer cell.

Elizabeth City State University Evaluation of Course and Instructor

NOT APPLICABLE
STRONGLY DISAGREE
DISAGREE
NEUTRAL
AGREE
STRONGLY AGREE

EVALUATION OF THIS COURSE

(NA)	SD	D	N	A	SA	The course requirements (projects, papers, exams, etc.) have been explained clearly at the beginning of the course and at other appropriate times.
(NA)	SD	D	N	A	SA	The methods (papers, tests, projects, etc.) for evaluating my work are clearly presented.
(NA)	SD	D	N	A	SA	The course is well organized.
(NA)	SD	D	N	A	SA	The course objectives were clearly outlined in the syllabus.
(NA)	SD	D	N	A	SA	I am significantly better informed in this discipline area as a result of this course.
(NA)	SD	D	N	A	SA	There was ample opportunity for questions and discussion.
(NA)	SD	D	N	A	SA	Assignments were always clear.
(NA)	SD	D	N	A	SA	The textbook(s) was/were well suited for the course.
(NA)	SD	D	N	A	SA	For me, the level of difficulty for this course was about right.
(NA)	SD	D	N	A	SA	There was a reasonable number of tests given in the course.
(NA)	SD	D	N	A	SA	The tests, class discussions, assignments and course objectives were related.
(NA)	SD	D	N	A	SA	My progress in this course is satisfactory.
(NA)	SD	D	N	A	SA	I would recommend this course to others.
(NA)	SD	D	N	A	SA	My own personal objectives for the course were met.

EVALUATION OF INSTRUCTOR OF THIS COURSE

1	The instructor starts the class promptly and on time.	SA	A	N	D	SD	(NA)
2	The instructor creates an atmosphere of respect.	SA	A	N	D	SD	(NA)
3	The instructor creates an atmosphere of fairness.	SA	A	N	D	SD	(NA)
4	The instructor makes the assignments and utilizes activities that are relevant to the course objectives and goals on the syllabus.	SA	A	N	D	SD	(NA)
5	The instructor's development and presentation of materials and learning experiences have been consistent with goals and objectives of the course.	SA	A	N	D	SD	(NA)
6	The instructor returns tests and assignments in a timely manner.	SA	A	N	D	SD	(NA)
7	The instructor holds the class for the full class period.	SA	A	N	D	SD	(NA)
8	The instructor's speaking ability in class is satisfactory.	SA	A	N	D	SD	(NA)
9	The instructor encourages participation, discussions, and questions.	SA	A	N	D	SD	(NA)
10	The instructor comes to class prepared.	SA	A	N	D	SD	(NA)
11	The instructor shows interest in my learning.	SA	A	N	D	SD	(NA)
12	The instructor's presentations cause me to think more critically and stimulate my intellectual curiosity.	SA	A	N	D	SD	(NA)
13	The instructor was available for conferences during posted office hours or by special appointment.	SA	A	N	D	SD	(NA)
14	The instructor was fair in his/her grading.	SA	A	N	D	SD	(NA)
15	Overall, I think the instructor is effective in teaching this course.	SA	A	N	D	SD	(NA)
16	I would recommend this instructor to others for this course.	SA	A	N	D	SD	(NA)

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Please write your additional comments on a separate sheet of paper and hand in with this form

Elizabeth City State University

Faculty/Course Evaluations
Spring 2004

	EVALUATION OF THIS COURSE													EVALUATION OF INSTRUCTOR															
	3	4	5	6	7	8	9	10	11	12	13	14	Section 1 Average	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Section 2 Average
45	4.45	4.45	4.50	4.50	4.35	4.15	4.45	4.55	4.40	4.30	4.60	4.60	4.45	4.45	4.55	4.50	4.55	4.45	4.45	4.30	4.60	4.60	4.45	4.40	4.45	4.50	4.45	4.40	4.35	4.47
56	4.67	4.56	4.67	4.67	4.33	4.44	4.44	4.67	4.56	4.44	4.56	4.56	4.55	4.56	4.67	4.56	4.56	4.56	4.56	4.44	4.56	4.56	4.56	4.44	4.56	4.56	4.56	4.44	4.44	4.53
50	4.56	4.50	4.58	4.58	4.34	4.30	4.45	4.61	4.48	4.37	4.58	4.58	4.50	4.50	4.61	4.53	4.55	4.50	4.50	4.37	4.58	4.58	4.50	4.42	4.50	4.53	4.50	4.42	4.40	4.50

Group Size = Number of students responding to survey.
Overall Rating = The average rating by students in classes.

Weights assigned to survey responses.

Strongly Agree = 5
Agree = 4
Neutral = 3
Disagree = 2
Strongly Disagree = 1

INTRODUCTION:

Raman spectroscopy is a technique that provides information about structure and intensity of the molecular of the investigated sample. In Raman spectroscopy a sample is irradiated with laser light that results in light scattering. The majority of scattered light has unchanged frequency that is called Ray-Leigh line and the rest is shifted in frequency that is called Raman effect. The shifted frequencies can be analyzed and presented as a Raman spectrum. The Raman effect is caused by molecular vibrations in the irradiated sample and thus gives information about the structure of the molecules. Raman spectroscopy has been widely used for the past 70 years for chemical analysis [1]. This technique also has been used to study single living cells [2-4] and detect single molecules adsorbed on the surfaces of tiny metal particles [5-6]. Recently a laser-tweezers-Raman spectroscopy (LTRS) system has been developed to manipulate and identification the single motile or floating biological cells and colloid particles in solution [7]. Compared to the conventional method of Raman spectroscopy [8-9], LTRS has some advantages. Those advantages include holding biological cell suspended in a liquid culture medium for a prolonged length of time, obtaining a better signal-noise ratio and effectively reducing stray light from the cover plate [10]. Near-infrared (NIR) laser sources have been used for their advantage in reducing potential photo-damage and sample degradation since small absorption can be reached at a near-infrared wavelengths for biological cells [11]. Raman spectroscopy is getting more and more practice as a noninvasive diagnostic method of cancer [12-13].

EXPERIMENT:

The experimental scheme is shown in fig. 1. A laser diode (Tiger series Littrow, 500 mW) near 790 nm is chosen both for trapping and exciting a brain cell in order to reduce both the fluorescence interference on the single cell spectra and the absorption-induced degradation of the cell. The wavelength of the laser diode is stabilized with the temperature and the excitation wavelength (slightly different from 790 nm) can be reached by tuning the temperature with the rate of ~0.3 nm/°C. 100mW output power is produced by controlling the driving current. After spatially filtered, the laser beam enters an inverted microscope (Nikon eclipse TE 2000-S) with an objective (100x, NA = 1.25) where the brain cells are tested. A 200-μm confocal pinhole aperture is used to reject most of the off-focusing Rayleigh scattering light of the trapped cell which is collected with the same objective which two notch filters are used to remove most the on-focusing Rayleigh scattering light. The Raman –scattering light is then focused onto an imaging Raman-spectrograph equipped with a liquid-nitrogen-cooled charged-coupled detector (CCD). To observe the image of the trapped cell, a green-filtered illumination lamp and a video camera system with a monitor are used. The spectral resolution of our confocal micro-Raman system is about ~6 cm^{-1}.

The microscope sample holder was made of a 4.0 mm thick glass slide with a 6.0mm diameter drilled hole that is sealed with two cover slips on both surfaces. The brain cells (Trapani & Associates Inc., New Orleans) were cultivated in a hank's balanced salt solution (Grand island, N.Y.) at room temperature. The cell culture was put in the hole between the two cover slips. The microscope sample holder was mounted on a

homemade temperature-controlled microscope stage equipped with a pair of Petri thermoelectric (TE) coolers and a temperature controller (TEC-2000, ThorLabs Inc., NJ). In order to minimize the laser power illuminating effects on trapped cell, the NIR diode laser was set a lower power (~5 mW) for trapping and relative high power (~20 mW) for a short period (~30 seconds) of Raman acquisition [7]. The cells are tested at the room temperature.

RESULTS AND DISCUSSION:

Figure 2 depicts the near infrared (NIR) Raman spectra in the range from 600 to1800 cm^{-1} obtained from Astrocyte (normal brain cell) and Astrocytoma (brain cancel cell). Compared with Cytoplasm of normal cell, as showed in figure2a, intensities of Raman bands at 878, 962, 1129, 1264, 1302, 1442 and 1660 cm^{-1}were found increased in Cytoplasm of cancer cell. These changes suggest the increasing concentrations of amino acids, α Helical, ν (C-N), Amide III [$\delta(C_{\alpha}H\text{-})$], Amide III(deformed)/ DNA (adenine and guanine), Lipid/protein [$\delta(\text{-}CH_2)$] and Amide I . Also we found a new peak at 1739 cm^{-1}in Cytoplasm of cancer cell that indicates Carboxyl ν (C=0) might be produced or denatured in cancer cell. Compared with nuclear of normal cell, as showed in figure2b, intensities of Raman bands at 783, 1093 and 1580 cm^{-1} were found increased in nuclear of cancer cell while decreasing was found at 937 cm^{-1}. These findings suggest that the concentrations of nucleic acid (cytosine and thymine), DNA ($O\text{-}P\text{-}O^{-}$) and nucleic acids (adenine and guanine) increased while DNA (backbone) might be degraded and thus its concentration reduced.

CONCLUSIONS:

We have tested brain normal cell and brain cancer cell by near-infrared Raman spectroscopy (NIR) and observed the changes in intensity and molecular structure of brain cells. By comparing from Raman spectra the main difference between cancer and normal cell is coming from protein. NIR is proved to be a useful tool for the understanding of fundamental cell processes.

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FIGURE CAPTIONS

FIG.1. Experimental setup. A temperature controlled (TC) diode laser (DL) beam passes through an interference filter (IF), a pinhole (PH) and then introduced into an inverted microscopy by a couple of reflection mirror (M) through a dichroic mirror (DM) to form an optical trap and collect the Raman scattering light of the trapped cell with same objective. The Raman –scattering light passes through a holographic notch filter (HNF1) and a pinhole (PH) and then focused onto the entrance of an imaging spectrograph equipped with a CCD detector by focal lens (L). BS—Beam splitter; Obj—objective lens; EP—eyepiece; VC—video camera; and Lamp—Green-filtered xenon illumination light.

FIG.2. (a) The NIR Raman spectra of Cytoplasm of cancer cell averaged over 15 cells (curve A) and the Raman spectra of Cytoplasm of normal cell averaged over 15 cells (curve B). (b) The NIR Raman spectra of Nuclear of cancer cell averaged over 15 cells (curve A) and the Raman spectra of Nuclear of normal cell averaged over 15 cells (curve B).

FIGURES

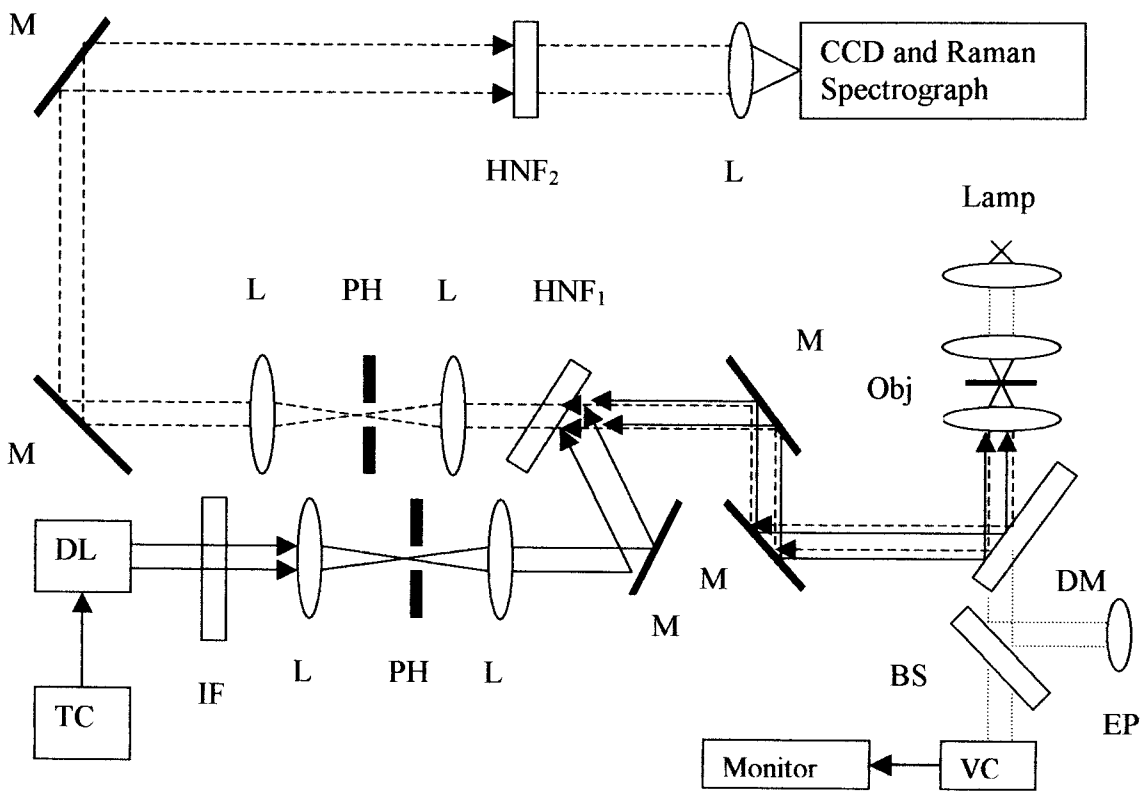

FIGURE 1.

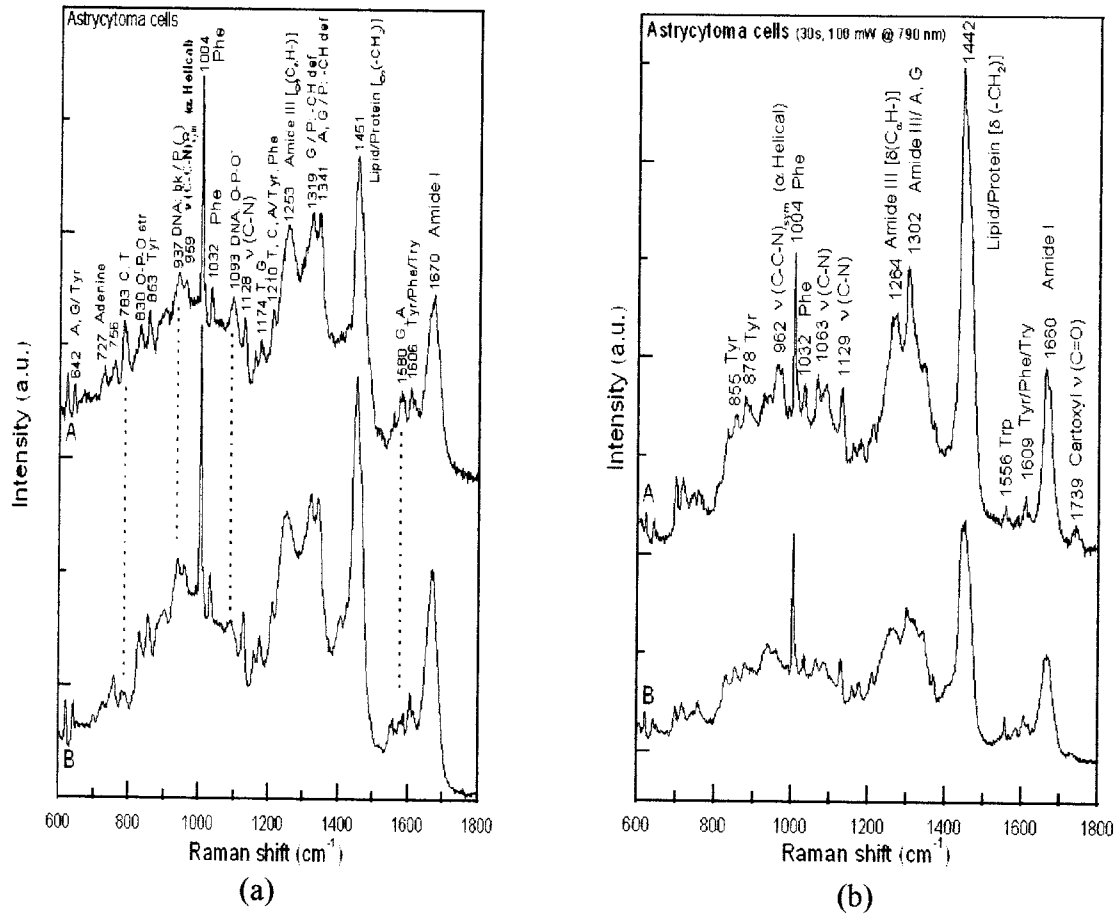
Astrycytoma cells
Intensity (a.u.)
Raman shift (cm-1)
642 A, G/Tyr
727 Adenine
783 C, T
830 O-P-O str
853 Tyr
937 DNA; bk./β(C-C)sym
959 ν(C-C)sym (α Helical)
1004 Phe
1032 Phe
1093 DNA, O-P-O
1128 ν (C-N)
1174 T, G
1210 T, C, A/Tyr, Phe
1253 Amide III [δ(CαH-)]
1319 G / P: CH def
1341 A, G / P: CH def
1451 Lipid/Protein [δs(-CH2)]
1580 G, A
1606 Tyr/Phe/Try
1670 Amide I
A
B
(a)
Astrycytoma cells (30s, 100 mW @ 790 nm)
Intensity (a.u.)
Raman shift (cm-1)
855 Tyr
878 Tyr
962 ν (C-C-N)sym (α Helical)
1004 Phe
1032 Phe
1063 ν (C-N)
1129 ν (C-N)
1264 Amide III [δ(CαH-)]
1302 Amide III/ A, G
1442 Lipid/Protein [δ (-CH2)]
1556 Trp
1609 Tyr/Phe/Try
1660 Amide I
1739 Cartoxyl ν (C=O)
A
B
(b)

FIGURE 2.