SECTION III – PHYSICS AND MATHEMATICS
Paper Session
Thursday Morning, 8:30 am– 12:00 pm
Arthur J. Bond Engineering Building, Room 119
Wen Yan & Matthew Edwards, Presiding

1. 8:30 HIGHLY DISPERSIVE OPTICAL SOLITON PERTURBATION WITH POLYNOMIAL NONLINEARITY BY SEMI-INVERSE VARIATIONAL PRINCIPLE. *Anjan Biswas,* Alabama A&M University.

   This talk is on the dynamics of perturbed highly dispersive optical solitons that maintains the polynomial law of nonlinear refractive index. The perturbative effects stem from self-steepening and nonlinear dispersions that are considered with full nonlinearity. The semi-inverse variational principle is adopted to obtain an analytical bright 1-soliton solution to the governing perturbed nonlinear Schrodinger's equation carrying these perturbation terms. The parameter constraints, which naturally emerge from the integration scheme, are also enumerated.

2. 8:50 RAPID PARTICLE ACCELERATION DUE TO RECOLLIMATION SHOCKS AND TURBULENT MAGNETIC FIELDS IN INJECTED JETS WITH HELICAL MAGNETIC FIELDS. *Kenichi Nishikawa,* Alabama A&M University.

   One of the key questions in the study of relativistic jets is how magnetic reconnection occurs and whether it can effectively accelerate electrons in the jet. We performed 3D particle-in-cell (PIC) simulations of a relativistic electron-proton jet of a relatively large radius that carries a helical magnetic field. We focused our investigation on the interaction between the jet and the ambient plasma and explored how the helical magnetic field affects the excitation of kinetic instabilities such as the Weibel instability (WI), the kinetic KelvinHelmholtz instability (kKHI), and the mushroom instability (MI). In our simulations, these kinetic instabilities were indeed excited, and particles were accelerated. At the linear stage we observed recollimation shocks near the center of the jet. As the electron-proton jet evolves into the deep nonlinear stage, the helical magnetic field becomes untangled due to reconnection-like phenomena, and electrons are repeatedly accelerated as they encounter magnetic-reconnection events in the turbulent magnetic field.

3. 9:10 **u MAPPING SOUND WAVES. *Suraj Thapa Magar,* James Sanders, Nicholas Johnson, Soumitra Ganguly, Caroline Howell, Troy University.

   Intensity of sound follows the inverse square law with respect to the distance from the source. The situation becomes more complicated in laboratory conditions that include possible reflections from all surfaces. These reflective surfaces act as virtual sound sources whose contributions lead to the interference of sound waves and thus a deviation from the inverse square law due to interference between reflected waves. The frequency of waves and the dimensions of the laboratory affect the interference at various points. The frequency, amplitude, and phase shift of the various reflected waves can be used to calculate the expected intensity of

the sound at various locations within the room; this is done with a simulation in Octave. Sound intensity levels were recorded as a function of distance from the front of a speaker. This was done for twenty trials with the data binned to average out outliers, such as inconsistency in background noise as well as averaging the positions to a fixed set of distances from the source. The experimental data were found to be in good agreement with the calculations of the simulation.

4. 9:20 A SPARSE BAYESIAN VECTOR REGRESSION MODEL. *Yijun Yu,* Tuskegee University.

   A sparse vector regression model is developed. The model is established by employing Bayesian formulation and trained by training data. The parameters of the model in the algorithm are reduced through taking special parameters. Therefore, the algorithm is simpler than usual and similar to the Bayesian vector regression model. Finally, the examples on test data are given.

5. 9:40 **u BUILDING AN ARDUINO-BASED SOUND SENSOR FOR MAPPING SOUND WAVES. *Nicholas Johnson*, James Sanders, Troy University.

   The intensity of a sound wave varies inversely with the square of the distance from the source to the point at which the intensity is being measured. An Arduino-based sensor module was designed to measure the sound intensity level while simultaneously measuring the distance from the source . To build the device, an Arduino Uno was used to control the operation of a LIDAR distance sensor and a sound intensity sensor module. The purpose for building such a device is to create a more accurate and compact alternative to current data collection methods, which involves using two separate devices that attempt to simultaneously measure sound intensity level and the distance longitudinally from the sound source. Data from both methods are collected and then compared to determine if the Arduino-based device is more effective than current methods.

6. 10:20 STATISTICAL APPROXIMATIONS OF GERNERALIZED NEGATIVE BINOMIAL DISTRBUTIONS. *Salam Khan*, Alabama A&M University.

   The generalized negative binomial distribution is a three-parameter distribution. This distribution is becoming increasingly useful in many branches of science, particularly related to customer service and queueing processes. Generalized distributions are becoming increasingly evident and useful in many branches of science, but the functional forms of these generalized distributions are often complicated. Therefore, a need arises for a more simplified or approximated form of this generalized distribution as well as an understanding of their relations with other distributions. Here, we approximate the generalized negative binomial distribution by using different techniques and suggest the best approximation. The results aim to fill a conspicuous gap in the mathematical and statistical literature that concerns the empirical quality of the approximations, and they are useful for designing efficient and accurate computing algorithms for such probabilities.

7. 10:40 **u ANGLE SCANS OF SCATTERED LIGHT INTENSITY. *Caroline Howell*, James Sanders, Nick Johnson, Troy University.

The intensity of scattered light from water droplets in steam changes when viewed from different angles. In this project, a laser is incident upon steam produced by boiling water, and it is scattered at different angles. The scattered light is then captured by a camera and analyzed in the computer program, OCTAVE. The intensity of the scattered light is dependent on the scattering angle, the intensity decreasing as the angle approaches 90 degrees from above or below. This effect can be explained by Mie Scattering, the scattering of electromagnetic waves by uniform isotropic particles. The water droplets in the steam absorbs and scatters the laser and transforms its energy into different forms, accounting for the low intensity at 90 degrees. This project maps the intensity of the light in OCTAVE by analyzing the pictures from different radial and polar angles.

8. 11:00 TRANSFORMING HIGH SCHOOL PHYSICS EDUCATION THROUGH TEACHER PROFESSIONAL DEVELOPMENT IN THE STATE OF ALABAMA. *Mohan Aggarwal*, Marius Schamschula, Vernessa Edwards, Barbara Cady, Dianne Kirnes, Matthew Edwards, Alabama A&M University.

   The Alliance for Physics Excellence (APEX), an NSF-funded project, has successfully completed seven years of implementation. The project was comprised of several components, each with its own subset of goals and objectives that relate to the project's overarching goal of transforming secondary physics education throughout the state of Alabama. One of the goals of APEX was to provide professional development training to high school physics teachers to increase their depth and breadth of physics content knowledge and pedagogy. Each participant committed to receiving intense physics content and pedagogical hands-on training by attending two-week summer workshops and three two-day academic weekend workshops over a three-year period. Additionally, instruction was infused with technology. Many of the laboratory activities performed during the APEX professional development training examined the relationship between different variables, such as the Four Step Analysis (an online assessment tool called "Diagnoser") and action research. All of these variables were used to accomplish the goals and objectives of the project. Participants worked in teams and used white boarding to understand, use, and share concepts. Equipment was donated to the Alabama Science in Motion for their mobile truck program to ensure that participants had access to equipment on which they had been trained. Many of the APEX strategies used for instruction in high school physics classes in Alabama have been adopted and used as evidence of APEX's impact and sustainability. Highlights of this activity and its effectiveness will be presented. Details of the project and its accomplishments can be accessed online at www.alapex.org.

9. 11:20 ENHANCEMENT OF THE ELECTROACTIVE β PHASE IN THE HYDROTHERMALLY-SYNTHESIZED Pr2o3 NANOPARTICLE INCORPORATED PVDF FILMS. *Arun Kuzhivelil Joseph*, Mohan Aggarwal, Alabama, Ashok Batra, Alabama A&M University; Sree Kerala Varma College , Thrissur, Kerala, India.

   Nanotechnologies are the design, characterization, production, and application of structures, devices, and systems by controlling shape and size at the nanometer

scale. Due to the unique physical, chemical, and mechanical properties and various potential applications, one dimensional (1-D) nanostructures have attracted great attention in the recent past. The oxide of the rare earth Praseodymium a prospective material with applications in fields like photonics, nano electronics and data storage. Poly (vinylidene fluoride), a flexible, cost effective fluoropolymer, has achieved much interest due to its wide range of significant applications. PVDF is a semi crystalline polymer, having five different crystalline phases: c.a. α, β, γ, δ and ε. Among all these phases, the non-polar α phase is the most common and thermodynamically stable state. On the other hand, β and γ phases are the polar phases of the PVDF. However, the polar β phase acquires more importance over the other phases due to its better piezoelectric, ferroelectric, and pyro electric properties. The present work deals with the synthesis of praseodymium oxide nanoparticles by hydrothermal method. Hydrothermally synthesized praseodymium oxide nanoparticles are incorporated in the PVDF matrix. Detailed analyses of the structural and optical properties of the PrO nanoparticles loaded PVDF films have been included in this study. The effect of the praseodymium oxide nanoparticles on the nucleation of the electro-active β phase in PVDF, along with the reason behind the significant improvement of the β phase fraction, has also been discussed from the physicochemical point of view.

10. 11:40 **u A STUDY OF LASER EXCITED FLUORESCENCE FROM RUBIES AND SAPPHIRES. *Isaiah Clotfelter*, D. Brian Thompson, University of North Alabama.

Rubies and sapphires are gem varieties of the mineral corundum. The red color of a ruby arises from trace amounts of chromium present in the corundum crystal that fluoresces red light. While the different colors of sapphires arise from trace impurities of other metals, chromium ions also exist in these gems, though in much smaller amounts. So, sapphires also fluoresce red light, although weakly. We have used green laser light to excite fluorescence in a wide variety of rubies and sapphires, collecting both spectra and lifetime measurements of the red fluorescence emission.

***u** or ***g** Denotes presentation entered in student competition as an undergraduate or graduate student, respectively.

SECTION III – PHYSICS AND MATHEMATICS
Poster Session
Thursday Afternoon, 1:00 pm – 3:00 pm
Arthur J. Bond Engineering Building Auditorium
Wen Yan & Matthew Edwards, Presiding

11. **g COMPOSITIONAL DEPENDENCE OF BORATE GLASSES FOR WHITE LIGHT EMISSION STUDIES. *Ashley Owens,* Alabama A&M University.

Light emitting diodes (LEDs) are efficient, energy-effective lighting solutions for commercial and residential applications. They come in two main forms: a single diode with many phosphor coatings that when excited release colored light that combines to form white light and a triple diode with a red, blue, and green configuration that combines to form white light. The problem is that many of these LEDs are made using harmful and toxic compounds, and they are expensive to purchase when compared to other lighting solutions available on the market. The purpose of this research is to develop an LED configuration that will generate white light using a single diode and a single phosphor coating while also avoiding the use of any harmful materials. Borate glasses have been proven to have optical properties suited for applications in LED lighting. Studies have shown borate glasses can generate white light when appropriate dopants are added. For this research, we will investigate the optical properties of borate glasses doped with dysprosium, samarium, terbium, and cerium in order to test its capabilities as a white light generator.

12. **u ABSORPTION AND LASER-INDUCED FLUORESCENCE STUDIES OF CHLOROPHYLL. *Clay Thompson*, Jayla Brantley, Ariana Black, Archana Sharma, Akshaya Kumar, Tuskegee University.

Chlorophyll is one of the most significant components of plants. It receives light energy from the Sun that is utilized in photosynthesis. The present study involves extracting chlorophyll from plant leaves and then recording their UV-VIS-NIR absorption spectrum and laser-induced fluorescence spectrum. The plant leaves were submerged in acidic solutions before extraction of chlorophyll. The effect on absorption and laser-induced fluorescence spectrum will be reported in this presentation.

13. **u QUANTIZED PARTICLES RESPONSIBLE FOR CONDUCTION. *Jared Savage,* Daniel Lindo, Taylor Jones, Prakash Sharma, Tuskegee University.

The work shows that the quantized particles responsible for the conduction can be calculated using the Bose-Einstein's statistics. Various approximations and the possible errors will be incorporated in the work. The n-type and p-type materials will be discussed.

14. **g INVESTIGATION OF PHOSPHATE GLASSES FOR WHITE LIGHT EMISSION. *Mersaydes Goodson,* Rami Bomareddi, Alabama A&M University.

Transparent barium phosphate glasses were created in air, utilizing the quench method. Each glass was characterized to include the trichromatic system, which suggests that white light can be created through the incorporation of the three primary colors (red, green, and blue), using samarium, terbium, and dysprosium respectively. The ratios were determined from the previous trials as were their luminescence results. The properties, emission peaks, and xy coordinates were reviewed to decide whether less or more of a material were needed. The optical emission and absorbance studies were carried out on these glasses to measure their energy levels. The emission spectra were recorded in UV-VIS region. Lifetimes were also measured. Silver particles were dispersed through the last sample. Heat

treatment was introduced to induce nanoparticles. The sample experienced multiple trials to determine if heat treatment had an effect on its luminescence properties. Metals, such as silver, gold, and copper, grow as nanoparticles upon heat treatment due to reduction and are known to enhance rare earth luminescence.

15. **u NLP ANALYSIS AND INTERACTIVE VISUALIZATION OF MOVIE DATA. *Sheng Gao*, Mingwei Sun, Samford University.

Understanding the popularity of movies is extremely important for producers and investors. The director, actor, and genre of a movie are the selling points of a movie, but they are not static over time. My research is dedicated to crawling movie data for analysis. First, I determined the theme of the movie. Then, I acquired the data, which is cleaned and filtered and ready to be visualized and analyzed. In addition, I crawled some high-rated movie reviews from different generations. Subsequently, I used sentiment analysis function to build in an NLTK package to rate all the reviews and compare it with the scores given by the audiences.

16. **u A SEARCH FOR VARIABLE STARS IN THE OLD OPEN CLUSTER NGC3680. *Derick Vickery*, Mel Blake, University of North Alabama.

Contact binaries are stars which orbit one another so closely that they share a common envelope. Contact binaries may form through close encounters or through stellar evolution. The youngest such contact binary is TX Cnc in the Praesepe. We have begun a project to search younger clusters to discover more contact binaries to further constrain the timescales that are required to form them. We report on a search for variable stars in the 1.2-billion-year-old cluster NGC3680.

17. **u PHONON SCATTERING IN PURE SEMICONDUCTORS. *Taylor Jones*, Jared Savage, Daniel Lindo, Prakash Sharma, Tuskegee University.

Phonon Scattering in pure semiconductors will be calculated by the crystal boundaries, impurities, and phonons . A model is developed and the new equation under Maxwell-Boltzmann Approximation will be presented. To test the validity of the model at low temperatures, we will apply it to calculate the phonon conductivity of a pure semiconductor and compare it with the experimental values.

18. **u A SPECTROSCOPIC STUDY OF DELTA SCORPIUS. *Harrison Whitaker*, Mel Blake, University of North Alabama.

We have used original and archival data to examine the changes in the H-Alpha line of Delta Scorpius, a Be star. Be stars are massive stars which have a circumstellar disk around them that varies with time. The reason for these changes is poorly understood, so monitoring these variations over time clarifies the processes. We have used 16 years of data on Delta Scorpius to study the changes in the strength of the H-Alpha line. Significant changes take place. The longest time frame is similar to the orbital period. We discuss the result of this study.

19. THE INDIAN ANTI-SATELLITE EXPERIMENT: FRAGMENTS DISPERSION ANALYSIS. *Arjun Tan*, Alabama A&M University.

The Indian Anti-Satellite (ASAT) experiment of March 27, 2019, created some unexpected results. Whereas the planned head-on impact of the ASAT with the target satellite was to minimize orbital debris production, the converse had happened. It has now been shown that

a series of explosions within the target following the impact was responsible for the debris production. This study analyzedthe magnitude, variance, and directionality of the fragments produced. It found that 95% of the fragments were ejected in the forward direction, 69% were ejected in the downwards direction, and 80% were ejected rightwards of the target when viewed from above. More than half of the fragments (58%) were ejected within just one octant (Octant VIII) of space. The angular distribution of the fragments was studied by defining angles of latitude and longitude at the breakup point and plotting them in an equidistant cylindrical projection map. The map clearly shows that the majority of the fragments were concentrated in a narrow solid angle within Octant VIII. The most energetic fragments, located near the periphery of this octant, strongly suggest that the target fragmented in the 'Clam' model of explosive fragmentation of propellant tanks.

20. **u ENERGY GENERATION FROM TRANSISTORS. *Mordecai Israel*, Rebecca Glenn, Zhigang Xiao, Alabama A&M University.

In this project, we researched the properties of transistors and, as such, will discuss transistors and how to generate power from them despite their size. Also, we will examine if other metal transistors behave better than silicon transistors. We have completed processes like deposition spin coding, photo lithography, EV evaporation, liftoff, and plasma etching/wet etching in order to evaluate the behavior of the transistors. These processes will assist in characterizing the transistors and help develop their functionality.

21. A CME-PRODUCING SOLAR ERUPTION FROM THE INTERIOR OF A TWISTED EMERGING BIPOLE. *Mitzi Adams*, Marshall Space Flight Center; Ronald Moore, University of Alabama in Huntsville; Sanjiv Tiwari, Lockheed Martin Solar and Astrophysics Laboratory; Navdeep Panesar, Lockheed Martin Solar and Astrophysics Laboratory; David Falconer, University of Alabama in Huntsville.

In a negative-polarity coronal hole, magnetic flux emergence, as seen by the Solar Dynamics Observatory's (SDO) Helioseismic Magnetic Imager (HMI), began at approximately 19:00 UT on March 3, 2016. The emerged magnetic field produced sunspots with penumbrae by 3:00 UT on March 4, which NOAA numbered 12514. The emerging magnetic field is largely bipolar with the oppositepolarity fluxes spreading apart overall. However, there is simultaneously some convergence and cancellation of oppositepolarity flux at the Polarity Inversion Line (PIL) inside the emerging bipole. The emerging bipole shows obvious overall left-handed shear and/or twist in its magnetic field and corresponding clockwise rotation of the two poles of the bipole about each other as the bipole emerges. The eruption comes from inside the emerging bipole and blows it open to produce a CME observed by SOHO/LASCO. That eruption is preceded by flux cancellation at the emerging bipole's interior PIL, a cancellation that plausibly builds a sheared and twisted flux rope above the interior PIL and finally triggers the blow -out eruption of the flux rope via photospheric-convection-driven slow, tether-cutting reconnection of the legs of the sheared core field, low above the interior PIL, as proposed by van Ballegooijen and Martens (1989, ApJ, 343, 971) and Moore and Roumeliotis (1992, in Eruptive Solar Flares, ed. Z. Svestka, B.V. Jackson, and M.E. Machado [Berlin:Springer], 69). The production of this eruption is a (perhaps rare) counterexample to solar eruptions that result from external collisional shearing between opposite polarities from two distinct emerging and/or emerged bipoles (Chintzoglou et al., 2019, ApJ, 871:67).

22. **u EFFECTS OF DOPING WITH MWCNT ON BANDGAP ENERGIES IN COMPOSITE THIN FILMS. *LaMaia Sanders*, Alabama A&M University.

There are numerous applications for the pyroelectric composite films in the medical field, construction field, and environmental applications field. The main focus of this research is to study the effects of MWCNT doping on the composite films' bandgap energies and thus, the optical properties of the films. PS is a manmade polymer that has been proven to be an excellent choice in sensing devises. PS is very useful when the detector is flexible, light weight, and possess high pyroelectric current and resistance.PS is also very useful when the detector has low dielectric constant and densities. In this research, PS films are doped with MWCNT, PS: ZnTiO3. Thin films, pure and doped with MWCNT, are fabricated using the solution casting technique. Films fabricated were characterized for their optical and structural properties using FTIR Spectroscopy. Results showed that the bandgap is reduced in all the films with the additional amount of PS: ZnTiO3 shows highest change in the bandgap energies. The decrease in the bandgap may be attributed to the presence of unstructured bulk defects. Obtained results show that the quantitative doping of PS and its nanocomposite material with MWCNT is enhancing the key characteristics of the materials that are beneficial for the optical devices industry.

23. **g IMPROVISING THE PERFORMANCE OF FERROELECTRIC POLYMER NANOCOMPOSITES VIA PEROVSKITE MATERIALS. *Sharvare Palwai*, Padmaja Guggilla, Alabama A&M University.

In the recent years, nanocomposites have exhibited a catalytic role in improving electronic and optoelectronic properties of conventional ferroelectric polymers, such as Polyvinylidene Fluoride (PVDF). However, perovskite materials, when slightly tuned, can create results appearing to have towering absorption potential, lower bandgap, higher dielectric constant, and more. In the present work, the influence of perovskite materials, such as calciumtitanate (CaTiO3/CT) and zinc titanate (ZnTiO3/ZT), in polymer films have been comprehensively studied . Films fabricated were characterized for optical studies that displayed improved absorption and finer spectral analysis.

24. **g DEVELOPMENT OF NANOCOMPOSITE FILMS FOR BIOMEDICAL APPLICATIONS. *James Sampson*, Adina Showe, Ashley Lewis, Ashok Batra, Kuzhivelil Arun, Alabama A&M University.

Polyvinylidene fluoride (PVDF) is utilized in a wide range of devices due to its excellent mechanical and optical properties, high thermal and chemical stability, piezoelectricity, Pyroelectricity, and ferroelectric responses. In the present investigation, the praseodymium oxide nanoparticles embedded into polyvinylidene fluoride (PVDF) thick films were fabricated via solution casting/intercalation technique. The praseodymium oxide nanoparticles were synthesized via hydrothermal technique. The Fourier transform infrared spectroscopy (FTIR) has been recorded in the range 500 to 4000 cm -1 and functional groups were identified in the nanocomposite films. Infrared vibrational spectroscopy (FTIR) revealed the presence of ferroelectric β-phase in the annealed nanocomposite films intrinsically. The electrical parameters, including piezo-capacitive and piezo-resistive, were determined. The results of their characteristics for use in biomedical applications will also be presented.

25. THE INDIAN ANTI-SATELLITE EXPERIMENT: PUZZLES AND ANSWERS. *Arjun Tan*, Alabama A&M University.

The Indian Anti-Satellite (ASAT) experiment of March 27, 2019, created some controversy. The destruction of the target satellite Microsat-R was planned by a head-on collision with a kinetic kill vehicle (KKV) so that most of the fragments produced by the backward impulse would deorbit rapidly and pose no threat to the space environment. However, several hundred fragments were spread forward and into higher orbits. This unexpected puzzle has been solved in this study by analyzing the collision via through orbital mechanics. The results show that, whereas collision alone was not responsible for the debris production, explosions resulting from the collision explain the fragments formation in the forward direction. Careful examination of the 'Gabbard diagram' suggests that at least two secondary explosions following the primary explosion took place after the target satellite was knocked into an elliptical orbit as a result of the collision with the ASAT.

26. . OBTAINING ELLIPTICAL SECTIONS BY INTERSECTING A RIGHT-CIRCULAR CONE WITH A PLANE. *Arjun Tan*, Alabama A&M University.

The popular topic of obtaining conic sections by intersecting right-circular cones with planes is readily found in books, journals, and the internet. However, a mathematical analysis of this topic is hard to find because a simple derivation has not been available to show that the outlines of the planar sections of conics indeed satisfy the equation of that conic. In this study, we show that one can obtain the Cartesian equation of an ellipse without too much mathematical intricacy. This process can be best demonstrated by intersecting a right-angled, right-circular cone with a plane. Elliptical shapes of any desired size and eccentricity can be made by choosing the slicing angle of the plane and the vertical intercept.

27. . SEMI-EMPIRICAL/ANALYTICAL FORMULAS FOR OPENING WICKET PARTNERSHIP IN TEST CRICKET. *Arjun Tan*, Alabama A&M University.

The opening wicket partnership is one of the most important factors which the outcome of a cricket match depends. In this study, the greatest opening partnerships in test cricket are studied, and various semi-empirical/analytical model partnerships are constructed in lieu of fully analytical ones. Factors such as the cumulative distribution of batting scores, the role of extras, and equal and unequal partners can be considered analytically. However, the correlation coefficient between the partners' batting scores plays an all-important role which can only be incorporated empirically.

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