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BUET PHYSICS BULLETIN

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MESSAGE FROM THE EDITOR

It gives us immense pleasure to announce that Department of Physics, Bangladesh University of Engineering and Technolgy (BUET), Bangladesh is releasing its first ever publication of the "BUET Physics Bulletin" (BPB) in this year, 2022. First, we welcome a happy new year and then we congratulate our success that we are finally able to publish this bulletin from our department in the current year. University or departmental bulletins are the sources of inspiration for students and faculties to express their creativity. These are culmination of articles, pictures, interviews, reports of events and many more. Based on these views, BPB has been launched to publish topics on several areas like scientific (Physics related) information/article, recent research achievements, academic achievements, information of ongoing research projects, scholarship and job information, contemporary scientific news, admission/departmental news, alumni news, photographs of departmental events, etc. Apart from all these interesting issues, one of the key objectives of this bulletin is to build up an amicable relationship among teachers, students and alumni. We are sanguine that BPB will act as springs for nurturing of talents an find a long and commendable tradition of cultivating talents and supporting inventiveness. We hope that BPB will live up to its meaning of letting the students and faculties expressing their inherent capacity to excel. We believe that while the publication of this bulletin will be a joyous occasion, it will also give opportunity for introspection with a view to have well-conceived plans for future with confidence that the progress so far made inspires. We extend our warm greetings and felicitations to those who have submitted their contributions to the first issue of the bulletin.

"One of the key objectives of this bulletin is to build up an amicable relationship among teachers, students and alumni"

We wish the best for your endeavors and tireless efforts.

Editor

LIGHTNING DISASTER IN BANGLADESH

***Dr. Md. Rafi Uddin**, Professor, Department of Physics, BUET*

Lightning is a natural phenomenon that occurs during thunderstorms by electrostatic discharge. Thunderstorms are created during the formation of cumulonimbus clouds (menacing looking multi-level clouds, vertically extended around 20 km) by the strong rising air called updrafts. Strong warm updrafts and cooler downdrafts create turbulence within thunderclouds resulting the interactions among hydrometeors [super-cooled liquid water, graupels (precipitation that forms when supercooled water droplets are collected and freeze on falling snowflakes, forming balls of crisp and opaque rime) and ice crystals]. The continuous collisions of different sized hydrometeors create strong electrical charges within the thunderstorm. The main charging area of a thunderstorm is the central part of the storm, where air is moving upward rapidly (updraft) and temperature remains from −15 to −25 °C. It is thought that updrafts carry the tiny positively charged particles to the top of the cloud and gravity pulls the larger negatively charged particles towards the bottom of the cloud which creates an electrical imbalance with an enormous electric potential of millions of volts across the storm cloud (*Mansell et al., J. Geophys. Res., 2005; Saunders et al., J. Geophys. Res., 1991*). This thunderstorm electrification process forms lightning as tremendous currents travel within clouds or across the air to ground (Fig. 1). There are three primary types of lightning: Cloud to ground, Intra-cloud and Cloud to cloud. Globally, nearly 1.4 billion flashes occur per year and 75% of total lightning flashes occur in the tropical zone. More than 25% of the global lightning activity consists of cloud to ground discharges and the remaining 75% discharges do not reach to the ground. These discharges may be negative or positive. About 95% of the cloud to ground lightning discharges is negative, where negative charge is transferred to the ground and electrons travel downward along the lightning channel, whereas the reverse happens in a positive cloud to ground flash, where electrons travel upward along the lightning channel and positive charge is transferred to the ground. Positive discharge flashes are less frequent but more powerful and deadly compared to that of negative flashes. Each discharge (or flash) typically contains 3 to 5 strokes and roughly half of all lightning discharges to earth strike the ground at more than one point, with the spatial separation between the channel terminations being up to many kilometers. Each year, lightning strikes kill people, livestock and wildlife. Lightning is also responsible for billions of dollars in damage to buildings, communication systems, power lines and electrical equipment. Annually about 2,000 people are killed worldwide by lightning, although there have been several recent estimates of the total number of global lightning fatalities that ranges from 6,000 to 24,000.

Fig. 1: Lightning in Bangladesh.

Bangladesh is one of the most lightning hazard-prone countries in the world. Recently, the fatalities in Bangladesh due to lightning have been increased devastatingly (*Dewan et al., Wea. Climate Soc., 2017*). Following the deaths of 89 people on 12 and 13 May 2016, Bangladesh government has declared lightning as a natural disaster. According to the Ministry of Disaster Management and Relief of Bangladesh, 1,164 people were killed by lightning from 2015 to 2018 in the country. Unfortunately, there is not much detailed research on lightning activity in Bangladesh. Spatiotemporal variation of lightning in Bangladesh indicates that in the months of April to June there have the highest occurrences, and the northeastern part of the country experiences maximum lightning flashes (*Holle et al., Int. J. Disaster Risk Reduct., 2019; Dewan et al., Int. J. Climatol., 2018*). The peak occurrence of lightning flashes is observed in the morning and afternoon during the pre-monsoon (March-May) and monsoon (June-September) seasons in Bangladesh. The lightning fatalities are highest in the month of May, and maximum (36%) is associated with agricultural activities (*Holle et al., Int. J. Disaster Risk Reduct., 2019*). April and June have fewer deaths than May; these three months account for 70% of the year's agriculture related fatalities. Although lightning is extremely dangerous but it also helps our agriculture by producing nitrates. When lightning strikes, it breaks the bond of airborne nitrogen molecules. Those free nitrogen atoms combine with oxygen molecules to form a compound called nitrate. Once formed, the nitrates are carried down to the ground by rainfall and plants can absorb this powerful natural fertilizer.

The main crop in Bangladesh is Boro rice and concentrated mainly in the northeast region Sunamganj and other central districts. Harvesting time of Boro rice is in the months of April and May, when most of the farmers are involved in the harvesting activities and must be needed to go outside. Therefore, the agriculture related activities are increased the lightning-related casualties in Bangladesh. Scientifically, it is possible to forecast the arrival of lighting associated thunderstorms in Bangladesh. If the farmers alert early about the possibilities of lightning occurrence, they will be able to find a safe location from lightning. In order to reduce lightning related casualties, government should establish such safe locations at least in the highly dense farming area like Sunamganj. In addition, government should conduct various awareness and tree plantation programs to aware the farmers and others about lightning safety guidelines.

PLASMA AND PLASMA PROCESSING OF MATERIALS

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Pro-Vice Chancellor, UITS

Sir William Crookes [1] first discovered plasma what he called as 'Radiant matter' in August 1879. Irving Langmuir [2] is one of the pioneers who started research to understand the matter and he introduced the term 'Plasma' as an ionized gas. Plasma is classified as the fourth state of matter along with solid, liquid and gas. In this state of matter, a substance is highly electrically conductive and usually ensures that the densities of positive and negative charges in any sizeable region are equal, i.e., "quasineutrality". Plasma can generally be classified in to four categories. i) Hot plasma (thermal plasma), ii) Warm plasma, iii) Cold plasma (non-thermal plasma) and iv) Ultracold plasma (Fig. 1).

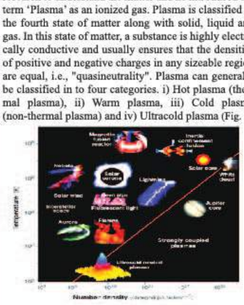


Fig. 1: Different form of Plasma.

Of them Hot plasma and Cold plasma are the main classes of plasma.

Hot plasma: It is superheated matter in which electrons are removed from atoms/molecules to form ions. Electrons and ions have nearly same energy i.e., equal temperature. It consists over 99% of the visible universe.

Plasmas in nature: Atmospheric plasma, Polar lights, Space plasma, etc.

Cold plasma: The temperature of the individual constituents is different from each other, i. e., non-equilibrium plasma. Electrons are at higher temperature (more than 10,000 K) and neutral atoms are at room temperature. This can be done at room temperature and at atmospheric pressure.

Various cold plasmas: Industrial plasma- plasma processing, plasma spray, plasma sources, etc.; Food processing; Plasma arc waste disposal/Recycling; Plasma medicine, etc.

Hot and cold plasmas can be produced in the laboratory using suitable power sources. The behavior and characteristics of plasma are very important to explore the universe and to use it in processing and preparation of materials. Scientists and technologists of various disciplines have received immense interest in exploring the production and properties of plasma due to these reasons. Plasma in materials processing and preparation is discussed in the rest of the article. In materials processing and preparation, the choice of cold plasma-generation in the laboratory and industry is very important. Some of them are mentioned below:

i) Power source: DC and AC (radiofrequency (RF) and microwave).
ii) Operation pressure: Vacuum (less than 1 Pa), Moderate pressure (about 100 Pa) and Atmospheric pressure (100 kPa).
iii) Degree of ionization: Fully, Partially or Weakly ionized.
iv) Type of electrode configuration: Capacitively coupled, Inductively coupled and Electrodeless.
v) Magnetization of plasma.

Example of industrial plasma: Because of their sizable temperature and density ranges, plasmas find applications in many fields of research, technology and industry.

i) Extractive metallurgy, ii) Plasma spraying (coating), iii) Plasma etching, iv) Metal cutting and welding, v) Aerospace engineering, etc.

Various types of discharges

(a) Low pressure:

i) Glow discharge plasmas (DC, <100 kHz),
ii) Capacitively coupled plasma (CCP) (13.56 MHz)
iii) Cascaded arc plasma source (low temperature, about 1 eV),
iv) Inductively coupled plasma (ICP),
v) Wave heated plasma (RF electron cyclotron resonance (ECR))

b) Atmospheric pressure:

i) Arc discharge, ii) Corona discharge, iii) Dielectric barrier discharge, iv) Capacitive discharge, v) Piezoelectric direct discharge, etc.

Plasma processing and preparation of materials are the technology of chemical modification of material surfaces and preparation of chemically engineered smart materials. Several techniques are mentioned below:

i) Plasma cleaning, ii) Plasma etching, iii) Plasma electrolytic oxidation, iv) Plasma fictionalization,
v) Plasma polymerization, vi) Corona treatment, etc.

There are several advantages of plasma processing over other conventional processes, such as i) No wet chemistry, ii) Environment friendly, iii) Fast processing speeds, iv) Ultrafine cleaning, v) Nontoxic environment, vi) Less expensive vacuum, etc.

In a single step one can achieve simultaneously cleaning, chemically fictionalization and improved adhesive bonding.

So far plasma, its importance and multifold applications in materials processing and preparation have been briefly discussed. Among all these branches of technological use of plasma, plasma polymerization and plasma functionalization are the popular and elegant techniques to prepare ultrathin plasma polymer films and for surface modification, respectively. They produce materials with unique physico-chemical properties in their respective fields of applications.

Looking to the interest of the researchers on the exciting properties of the materials prepared using plasma technology and their applications in engineering and technology, a materials science laboratory has been established in the Department of Physics, BUET. A lot of research work has been done and has put impact in the national and international arena of research on plasma polymerization and nanocomposites of functionalized nanoparticles. This discussion does not allow any research activity. The research activities and achievements can be discussed in future.

Sources consulted:

[1] Crooks, Sir William (1832-1919), "Chemist and science journalist". Oxford Dictionary of National Biography (Online), Oxford University Press, 2004.
[2] Langmuir, Irving (1919), "The Arrangement of Electrons in Atoms and Molecules", J. Am. Chem. Soc. 41(6), 868-934.

SINGLE CRYSTALS: THE SCIENCE BEHIND ITS BEAUTY, POWER AND ENERGY

***Dr. Jiban Podder**, Professor, Department of Physics, BUET*

'Everything is energy and that's all there is to it. This is not philosophy. This is physics.'
-Albert Einstein

The great physicist Albert Einstein said that everything else in the universe has their own unique vibrational frequency. In all the stability of a crystal matter, there are, more stable energy = more powerful energy. And powerful energy can influence the energies around it. This is why crystals can so profoundly influence unstable energy, have a super stable energy frequency that doesn't change.

Crystals are the most orderly structure that exists in nature and have the lowest amount of entropy. A crystal is a solid in which the constituent atoms, molecules, or ions are packed in a regularly ordered, repeating pattern extending in all three spatial dimensions. Single crystals are one of the most important groups of materials due to their continuous, uniform, and highly-ordered structure which enables them to possess unique properties. In many aspects, single crystal materials can be found to be advantageous over polycrystalline materials, and many properties which are found in single crystals cannot be replicated in poly-crystals. A poly crystal is an aggregate of crystals which are irregularly shaped and interlocked together at the boundaries of contact. The ordered array of atoms repeated throughout the entire crystal, regardless of its size, by which entire block of the material is built is called single crystal. The ordering of atoms in the crystal is the cause of many important physical properties such as birefringence, piezoelectricity, ferro-electricity, ferromagnetism, etc. The absence of the defects associated with grain boundaries can give single crystals unique properties, particularly mechanical, optical and electrical. These properties make them precious for technological applications ranging from microelectronics, optoelectronics, medical instruments, radar systems, communication systems, defence, laser sources to the space vehicles, cell phones to satellites and electronics, etc.

Crystal growth is a highly interdisciplinary subject and one of the thrust areas of science and technology which attracts and demands the collective contribution of physicists, chemists, biologists, crystallographers, material scientists, material engineers and industrialists from many disciplines. The significance of the beauty and rarity of crystals is now well knitted with their symmetry, molecular structure, purity and the physicochemical environment of their formation. That's why research always attract human mind because of the wonderful geometry, transparency, shiny and glittering surface, sharp bounded planes and hardness.

In materials science, the growth of single crystals and its characterization has got enormous importance for both academic research and in the field of electronic industry during the last few decades. are the pillars of modern technology. Without crystals, there would be no electronic industry, no photonic industry, and no fiber–optic communications. Single crystals form the foundation for modern technology. Specifically, single crystal semiconductors are one of the most widely researched and used materials. These materials have been applied for various electronic and optoelectronic devices and components, such as light-emitting diodes (LEDs), photodetectors, wide-bandgap devices, high-power lasers, consumer electronics, and more. In fact, current computer chip production is not possible without high-quality single crystal silicon (Si) wafers. Due to their outstanding optical and electronic properties, single crystals of III–V semiconductors, such as GaAs, GaN, InP, InAs, and others, are an integral part of devices for application in fiber-optic communication, wireless and satellite communication, solid-state lighting, and more.

Growth Mechanism

Crystal growth was an important field of materials science, which involves controlled phase transformation from supersaturated mother phase to solid phase. The slow solvent evaporation in low temperature solution growth technique is an old but active and easy method to grow single crystals at low cost and largely used method in now a day.The formation of a liquid or a solid particle from liquid demands an expenditure of certain quantity of energy, ΔG, the overall excess free energy represented as a combination of volume and surface energies:

$$\Delta G = \Delta G_v + \Delta G_s$$

where, ΔG representing the free energy change per unit volume is a negative quantity, and ΔGs is the free energy change per unit surface area.

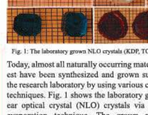


Fig. 1: The laboratory grown NLO crystals (KDP, TGS, and ADP).

Today, almost all naturally occurring materials of interest have been synthesized and grown successfully in the research laboratory by using various crystal growth techniques. Fig. 1 shows the laboratory grown nonlinear optical crystal (NLO) crystals via slow solvent evaporation technique. The grown materials are subjected to various characterization techniques such as single crystal and powder X-ray diffraction (XRD), Fourier Transform Infrared and Fourier Transform Raman spectroscopy, UV-VIS transmission, Mechanical, Thermal and Second Harmonic Generation (SHG) efficiency studies.

Nonlinear Optical Crystals: Inorganic, Semi-organic Crystals

The optical phenomenon that deals with the interaction of laser beam with a nonlinear optical medium is called nonlinear optics and the medium is termed as nonlinear optical material. Numerous inorganic, organic and semi organic materials are extremely polarizable, and as a result, they are widely used for NLO study. Inorganic materials are prominent in their applications to second-order NLO. Inorganic crystals are mostly ionic bonded and always easier to synthesize. Inorganic materials like Potassium dihydrogen phosphate (KH_2PO_4) or KDP crystals, Lithium iodate ($LiIO_3$), Lithium niobate ($LiNbO_3$), Potassium niobate ($KNbO_3$), Lithium triborate (LBo), potassium titanyl phosphate (KTP) and β-Barium Borate, etc. are the inorganic crystals well-known for nonlinear optical properties. Semi-organic NLO single crystals like 4-aminophenyl sulphonyl oxy zinc (II) chloride (4-ASZC), L-Ghutamic acid hydrochloride (LGHC), L-proline zinc chloride (LPZ), L-arginine phosphate (LAP), L-arginine hydrobromide (L-AHBr), L-histidine nitrate (LHN), L-arginine hydrochloride (L-HCl), and glycine sodium nitrate (GSN) have also attracted attention because they have been proposed as a new approach for materials with fascinating NLO properties which have the combined properties of both inorganic and organic crystals like high mechanical strength, wide transparency range, less deliquescence and high nonlinear coefficients that make them suitable for device fabrication.

Physical Explanation

When an electromagnetic radiation passes through a dielectric substance, the oscillating electric field of the radiation polarizes the material and induces an oscillating electric dipole. But, under high intensity of light, the excited photons in the matrix can be excited to higher energy level, and emitted light with higher energy than the incident light energy. This is nonlinear optics, in which new waves have been created. Fig. 2 shows the non-linear phenomenon of NLO crystals

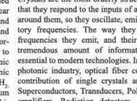


Fig. 2: Phenomenon of NLO crystals.

Non-linear effects arise from contributions to polarization of molecules, P, which depends on higher powers of applied field.

Contribution of Crystals

Crystals are the most orderly structured in such a way that they respond to the inputs of all different energies around them, so they oscillate, emitting specific vibratory frequencies. The way they are balanced, the frequencies they emit, and their ability to store a tremendous amount of information make crystals essential to modern technologies. In electrical industry, photonic industry, optical fiber communications, the contribution of single crystals are Semiconductors, Superconductors, Transducers, Polarizer's, Ultrasonic amplifiers, Radiation detectors, Ferrites, Magnetic garnets, Nonlinear optics, Piezo-electric, Acoustic-optic, Electro-optic, Microelectronics, Computer industries, Solid state lasers. The non-cento symmetric structure of polar organic crystals forms a larger second and third order nonlinear optical property. Nonlinear optical (NLO) crystals possess wide range of applications among all other crystals. These materials could be used to double or triple the frequency of laser light for high-speed processing of data. The laser damage threshold of non-linear optical crystals, used for frequency conversion Q-switches, parametric oscillators, etc , depend on the growth imperfections (dislocations, growth inclusions) and the concentration of impurities. Optical fibers, which are used effectively in communication, are proving superior to electronics in terms of bandwidth and noise signal. Day by day the demand for nonlinear optical crystals with superior properties of nonlinear optical devices with higher performance is increasing in crystal growth technology

HOW AND WHY A LARGE VORTEX OF TROPICAL CYCLONE MOVES FORWARD?

***Dr. Nasreen Akter**, Professor, Department of Physics, BUET*

The Nobel Prize in Physics in the year 2021 was awarded to Prof. Sukuro Manabe and Prof. Klaus Hasselmann for their work on "Physical modeling of Earth's climate, quantifying variability and reliably predicting Global warming". I am very proud to be a member of Atmospheric Science fraternity, and thus, would like to explain one of the most hazardous atmospheric events affecting civilization in a comprehensive approach.

Introduction

A tropical cyclone (TC) is a large cylindrical vortex occurring in the atmosphere with a horizontal diameter of 100s of kilometers. The rotating TC that rises vertically up to ~20 km in the atmosphere comprises several numbers of convective storms in the rainbands connecting through the eyewall (Fig.1) A great concern for the inhabitants as well as the administration is how and which direction the massive vortex moves or proceeds. Interestingly, TCs that formed in the northern hemisphere are translating upward (toward the pole), but not in downward (to the equator) direction or vice-versa for the southern hemisphere (Fig. 2) More precisely, it can be stated that the TCs in the northern hemisphere follow the regular path in the west or poleward west direction. Some TCs that take the turn to the east or poleward east from their regular paths are called recurving TCs. More than 50 percent TCs that formed over the Bay of Bengal (BoB) were curved or diverted from their original/initial tracks

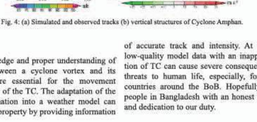


Fig. 1: Tropical cyclone (a) horizontal and (b) vertical structure (Source: NOAA)

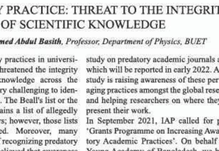


Fig. 2: Typical track of tropical cyclones (Source: NASA)

Cause of TC movement

The reasons that support a TC to move onwards are appended below:

i. Steering flow: This is the surrounding environmental wind flow where a TC is floated or embedded in the atmosphere. Most of the research revealed that surrounding flow and its dynamics largely govern the TC movement. However, the low-level surrounding flow (from surface to 6 km) does not have any significant effect on the translational motions of a TC, rather it takes part in the rotational motion (vorticity). High-level environmental flow, i.e., winds at ~6-9 km height (or 500-300 mb pressure level) bring the TC in forwarding motion. But TC is not just like a leaf that is steered by the current in the stream. The complex interactions between cyclone vortex and environmental flow are important issues to be considered.

ii. Beta effect (or beta gyres): This is an effect due to the earth's rotation. The earth vorticity interacts with TC vorticity and causes diversion from the steering flow, although its influence is less compared to steering flow.

iii. Vertical wind shear: This is the difference between the lower to upper-level winds, which contributes significantly to the vortex propagation. It also impacts on the orientation and strength of the beta gyres. The shear tilts the TC vortex and helps forward movement shown by a schematic diagram in Fig. 3.

iv. Diabatic heating: This is the latent heat released from the existing clouds i n the TC. This heat modifies the temperature structure of different layers in the atmosphere and thus the wind shear.

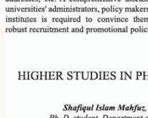


Fig. 3: Schematic diagram of TC vortex movement.

Predictions of TC movement

The prediction of the TC track has been updated tremendously through the advancement of recent research on the TC movement process. Now-a-days, a number of organizations like the Joint Typhoon Warning Center (JTWC), Indian Meteorological Department (IMD), European Centre for Medium-Range Weather Forecasts (ECMWF), etc. are very successful to forecast TC tracks beforehand. The precise forecasting, followed by the early warning arrangements are definitely a lot to mitigate disasters through assessing risks and vulnerability, especially, coastal counties of the BoB. Due to lack of accurate track prediction, it was earlier hard to know in which direction, or on which coast the TC would be landed. Because of confusions and limitations, our country had to loss 224,000, 138,000 and 130,000 people in the cyclone of Bhola (May 1970), BoB (2 April 1991) and Nargis (April 2008), respectively. On the other hand, after the landfall of intense cyclone Amphan (May 2020) to the coasts of India and Bangladesh, the death tolls were 128, which was significantly less than that of the previous TCs. A glimpse of TCs track prediction can be made clear in the next section explaining the track predictions of Cyclone Amphan, which was carried out in the Atmospheric lab, Department of Physics, BUET.

Simulation of Cyclone Amphan (May 2020)

Cyclone Amphan developed in the pre-monsoon season over the BoB had an intensity of category-5 (maximum wind speed of 240 km/h). The TC made landfall over the Indian coast and passed through Bangladesh as a deep depression. Cyclone Amphan was simulated for 4 days using a high-resolution weather model named The Weather Research and Forecasting (WRF). The simulated track (black) follows almost the similar path collected from the IMD track (white) with a minimum track error (Fig. 4a). Simulated Amphan made landfall exactly the same position as observed in reality. The vertical cross-section along the center of Amphan (Fig. 4b) clearly indicates that the horizontal diameter is 1500 km, the height of the TC is ~15 km and a clear, calm eye is visible for matured Amphan. This is really hard to imagine how this large cylindrical vortex is floating in the atmosphere and moving along the 500-300 mb environmental current (Fig. 4b). Not only that, it has traveled approximately 2000 km from the south BoB to Bangladesh.

Fig. 4: (a) Simulated and observed tracks (b) vertical structures of Cyclone Amphan.

Conclusion

The adequate knowledge and proper understanding of the interactions between a cyclone vortex and its surrounding flow are essential for the movement process and intensity of the TC. The adaptation of the upgraded TC information into a weather model can save human life and property by providing information of accurate track and intensity. At the same time, low-quality model data with an inappropriate prediction of TC can cause severe consequences and persist threats to human life, especially, for the low-lying countries around the BoB. Hopefully, we can save people in Bangladesh with an honest way of thinking and dedication to our duty.

PREDATORY PRACTICE: THREAT TO THE INTEGRITY OF SCIENTIFIC KNOWLEDGE

***Dr. Mohammed Abdul Basith**, Professor, Department of Physics, BUET*

The prolific growth of predatory practices in universities and research institutes has threatened the integrity and credibility of scientific knowledge across the globe. Day by day, it is being very challenging to identify and track predatory journals. The Beall's list or the Cabell's Predatory Reports contains a list of allegedly predatory journals and publishers; however, those lists are not always well updated. Moreover, many researchers are also not aware of recognizing predatory journals using these lists. It is believed that awareness creation is one of the most essential keys to tackle this global concern.

Notably, to explore the merit of young researchers, a dynamic movement has emerged throughout the world in the past few decades to establish independent Young Academies (YAs). Consequently, the Global Young Academy was officially founded in February 2010 in Berlin, Germany, with the InterAcademy Partnership (IAP) support. IAP is currently conducting a unique study on predatory academic journals and conferences, which will be reported in early 2022. A vital part of this study is raising awareness of these pervasive and damaging practices amongst the global research community and helping researchers on where they publish and/or present their work.

In September 2021, IAP called for proposals to the 'Grants Programme on Increasing Awareness of Predatory Academic Practices'. On behalf of the National Young Academy of Bangladesh, we have submitted a proposal for this grant programme. Obviously, the purpose is to create awareness among researchers and stakeholders outside the research community by i. organizing a number of workshops/seminars, ii. developing and providing easy access to an informative website, iii. arranging meetings with policy-makers and academic leaders to request and recommend to take essential steps to curb the tide of predatory practices. In the long run, we aimed to integrate our developed website with existing library systems across the country. We also have a plan to develop a web-based tool ("*Predacitve*" = *predatory detective*) using advanced machine learning algorithms to track and flag articles published in predatory journals from Bangladesh and send a notification email to alert the author(s), discouraging future submissions in that journal.

It is essential to organize workshops, seminars, and discussion meeting to identify predatory parameters, e.g hidden article processing charges, quick review process, fake editorial-board, deceptive titles, and addresses, etc. A comprehensive discussion with the universities' administrators, policy makers and research institutes is required to convince them to develop robust recruitment and promotional policies and selection criteria. The interaction with editors, local publishers, and library administrators is vital to let them realize the adverse consequences of predatory publications and the benefits of practicing non-predatory parameters.

Department of Physics, BUET, has a proven track record of peer-reviewed publications in different prestigious journals. Every year on average, more than thirty research papers are published in the peer-reviewed journals of reputed publishers like American Institute of Physics, Institute of Physics, UK, Royal Society of Chemistry, Elsevier, Springer etc. Fortunately, in last few years, the record for publishing in predatory journals from this department is almost zero. To make this number absolutely zero, there is no alternate to creating awareness among our researchers.

HIGHER STUDIES IN PHYSICS ABROAD: PROSPECTS, CONCERN, AND HOPE

***Shafiqul Islam Mahfuz**, Former M. Sc. Student, Department of Physics, BUET*
Ph. D. student, Department of Physics, University of Alabama at Birmingham, AL, USA

The students of Bangladesh studying physics abroad have a long-held dream. Selection of higher education destination is determined by the elements such as ranking of the university, tuition fees, living expenditures, etc. The universities of European and Asian countries, United States, Canada, and Australia are now drawing a lot of attention to physics students.

One of the best things about studying Physics is its broad spectrum of applications which lead the Physics graduates to many different job paths in diversified fields. Physics graduates are often found doing various jobs such as accelerator operator, data analyst, design engineer, physics teacher, IT consultant, lab technician, and laser engineer. In Bangladesh, most of the Physics graduates do not continue their higher education or build up their career in Physics due to inadequate Physics-based job opportunities.

Since last few years, the number of Bangladeshi students opting for higher study at foreign universities has surged. I believe that more students should study abroad, that might be the beginning of a new chapter in their lives. Many doors will open for them as they prepare for this significant step in their life. Although the number of Bangladeshi pupils is increasing in foreign universities, still now, it is small relative to the total number of students. In my university (University of Alabama at Birmingham, AL, USA) there are many South Asian students in both undergraduate and graduate levels. But we (Bangladeshis) are a small group. This is the common scenario of most of the US universities.

I observed few reasons why our students are less than those in other countries in the subcontinent. Firstly, they lack motivation because they believe they are not good enough students to pursue their ambitions of further education abroad. Secondly, as undergraduate students, despite their good academic backgrounds, are frightened of appearing the tests like GRE, IELTS, TOEFL, etc. In addition, lack of research experience and poor CGPA are also significant obstacles. Furthermore, another important factor is that today's youngsters prefer to be a power player rather than a scientist or a notable researcher. As a result, engineering, medical, and science students from top universities are very much attracted to civil service and various government professions.Many students of our country do not know that GRE is no longer required for admission in most of the US universities. So, I would recommend instead of spending time in preparing for the GRE, students can involve themselves in gathering some research experience if possible. Although publication is not an essential requirement for getting a funded admission, some research experience may put a student ahead in the competition. A good statement of purpose and some strong recommendations can help a student overcome a low CGPA. As an international student, a student must take an English proficiency test. Students should prepare themselves for the test for a couple of months. But they should keep in mind that studying for a language test may require different tactics than studying for a science or arts topic. Getting a graduate teaching assistant position may require a good score in this test particularly in speaking section.

Finally, I encourage Bangladeshi students to go abroad for higher education and build up their career in physics. Because the job market in Bangladesh is currently skewed, particularly for people with physics background. Thousands of students are graduated in Physics each year and physics related job opportunities are not yet increasing in proportion to the number of graduates. As a result, many promising Physics graduates are being deviated from their physics based career goals. So, instead of having a government job, consider being a physicist. Keep in mind that if anyone does not pursue a lucrative administrative position, someone will take his/her place, but who will be the next Jamal Nazrul Islam? Nobody… It's up to you to take the lead!

BUET M. Sc. PROGRAM: MY EXPERIENCE & RESEARCH

***Jakiul Islam**, Former M. Sc. Student, Department of Physics, BUET*

It's really a great pleasure for us that Department of Physics, BUET is going to publish a yearly e-magazine entitled *'BUET Physics Bulletin'*. I am delighted to write about my journey in BUET. I have been awarded B.Sc. (honors) degree in Physics from Pabna University of Science and Technology (PUST) securing first position with a CGPA of 3.69 in a scale of 4.00. When I have been selected in the admission test, I was very much confused and hesitant about the enrolment at BUET. It was a very hard time for me when I left PUST for BUET where I have many joyous memories with my fellow friends and teachers. However, after attending Physics classes and seminars, I realized that studying Physics in BUET is so interesting. All teachers are very much cordial, friendly, careful and research minded to make Physics more understandable to the students. Now I believe that I made the right decision about admission in BUET. I obtained M. Sc. degree in Physics (December-2020) from BUET securing a CGPA of 3.92 (out of 4.00) with the first position. I learned a lot from our esteemed teachers during my Teaching Assistantship in the Physics Undergraduate Laboratories. During my Master's degree, I carried out research on metal halide perovskites using Density Functional Theory based *ab-initio* calculations. I have six research publications in international peer-reviewed Journals. I am pleased to mention that I published five research articles after joining M. Sc. program in BUET. I published three research articles in Q1 Journals as a first author (*Journal of Alloys and Compounds-Elsevier, RSC Advances-Royal Society of Chemistry, and Scientific Reports-Nature Publishing Group*).

In my Master's thesis work, doping in and pressure effects on $CsSnCl_3$ perovskite were investigated. The metal-doped (Cr and Mn) $CsSnCl_3$ exhibited enhanced optical absorption and conductivity, which suggested that the doped $CsSnCl_3$ can be a prominent candidate in potential optoelectronic device applications. The metallic behavior as well as outstanding optoelectronic properties of semiconducting $CsSnCl_3$ were found under elevated pressure with DFT calculation. The pressure study on $CsSnCl_3$ was carried out using Generalized Gradient Approximation along with Perdew-Burke-Ernzerhof, which underestimated the band gap value compared with experimental observation. As a result, more theoretical investigations with different functions and experimental research were suggested to carry out on $CsSnCl_3$. I am pleased to notify that our research works on halide perovskites have attracted significant attention by the researchers, because these have already been cited more than 26 times. There are still a lot of scopes to work on such metal halide perovskites. In 2020, Snider et al. revealed room temperature superconductivity in a carbonaceous material under elevated pressure (267 ± 10 GPa). Though, they reported the superconducting phenomenon under very high pressure, but it has introduced a new thrust to the research community to search novel superconducting materials with fascinating properties. Now I am working on $ThCr_2Si_2$ type superconductors. I am also working on novel chiral noncentrosymmetric superconductors, and an article is ready to submit in a peer-reviewed Journal. I have attended two national conferences and one international conference. I worked as a member of the Scientific sub-committee at the 6th conference of Bangladesh Crystallographic Association. I strongly believe that the skill and expertise which I gained during my M. Sc. studies, will pave the way to achieve my desired goals in future academic endeavors.

CLIMATE OF BANGLADESH

***Jannatul Ferdous Flora**, M. Sc. Student, Department of Physics, BUET*

Climate is defined as the average condition of the atmosphere near the earth's surface over a long period of time, typically averaged over a period of 30 years. Bangladesh is located in the tropical monsoon region and its climate is characterized by high temperature, heavy rainfall, often excessive humidity, etc. From the climatic point of view, three distinct seasons can be recognized in Bangladesh such as the cool dry season (November through February), the pre-monsoon hot season (March through May) and the rainy monsoon season (June through October). April is the hottest month in Bangladesh when the average temperature ranges from 27 °C in the southeast part to 31 °C in the west-central part of the country. In the western part, the temperature during summer sometimes reaches up to 40 °C. January is the coldest month of Bangladesh, and in late December and early January, minimum temperature in the extreme northwestern and northeastern parts of the country reaches within 4 to 7 °C.

Bangladesh Meteorological Department prepares the weather reports of the country and this department is responsible for observation, recording, operation and maintenance of weather stations and weather instruments, and for reporting of daily/weekly weather information to the public. All weather stations around the country transmit their recorded data electronically to the Headquarters of the meteorological department in Dhaka.

Bangladesh has a long history of natural disasters such as cyclones, floods, storm surge, river bank erosion, earthquake, drought, salinity intrusion, tsunami, etc. Most rains occur during the monsoon (June-September) and little in winter (November- February). Cyclone occurs in Bangladesh as a natural hazard. The temperature and precipitation patterns are of great importance for an agro-based economy like the economy of Bangladesh. Therefore, these changes will threaten the significant achievements of Bangladesh, which has been made over the last 25 years in increasing income and reducing poverty. The Government of Bangladesh is fully committed to manage the climatic changes of Bangladesh and has already taken some steps.

APPLICATION OF PIXE TECHNIQUE

***Sourav Bhowmik**, M. Sc. Student, Department of Physics, BUET*

Particle-induced X-ray emission or proton-induced X-ray emission (PIXE) is a non-destructive, elemental analysis technique widely used for trace element and multi-element analysis. When a material is exposed to an ion beam, atomic interactions occur that give off electromagnetic radiation of wavelengths in the X-ray part of the electromagnetic spectrum specific to an element. PIXE is a powerful non-destructive elemental analysis technique now used to analyze a diverse range of specimens, including air filters, semiconductor wafers, archeological artifacts, crystalline, and liquid proteins, thin films, geologists, art conservators, and others to help answer questions of provenance, dating, and authenticity. The method of PIXE analysis is now a sufficiently sophisticated technology and is highly suitable for the analysis of biological, medical, and environmental samples. A blood sample can easily be analyzed by extracting a small quantity from the body and placing it on a thin film and measure at the cellular level. Production of elemental maps for biological sections of both hard and soft tissues has provided essential trace elements.In the biomedical field, hair

has been studied extensively with micro-PIXE to find correlations between trace elements in hair and blood or tissue; radial scans across a single hair can distinguish between the different routes followed during the incorporation of trace elements in hair, including environmental exposure. Longitudinal scans, on the other hand, provide information in time. PIXE is an ideal technique for the multielement analysis of aerosols filtered out of the atmosphere. This technique is used in many laboratories that have embarked on programs on environmental pollution. Analysis of airborne dust has been carried out for many years and has contributed to the prevention of environmental destruction by air pollution. Dust in the atmosphere is collected using an aerosol sampler with a nucleopore membrane filter, which contains many small holes and is used as a backing film for PIXE analysis. The filters or other collection surfaces from various types of samplers can be placed in the beam without any pretreatment, and if necessary it can be fully automated to obtain large datasets that are of statistical significance.

To an increasing extent, geological and archaeological samples have been analyzed by PIXE, including objects of art. PIXE analysis of river water using a condensation method based on colloids and precipitation. Elemental analysis is quite helpful in the identification of criminal crime-related samples, with the possibility of identifying the criminal. However, the PIXE technique is to limit with atomic numbers of less than 14, because of the heavy attenuation of the X-rays from the lighter elements. Heating due to proton bombardment may lead to the evaporation of volatile impurities and extreme care is to be taken in target preparation. However, these analytical techniques have been refined to give better detection limits higher accuracy

SOUTHWEST MONSOON AND FLOOD OVER BANGLADESH

***Subrina Akter**, M. Phil. Student, Department of Physics, BUET*

Bangladesh is a small country (with 148560 square kilometers area), in South Asia, located on the northern side of the Bay of Bengal. It is surrounded almost entirely by neighboring India and shares a small border with Myanmar to its southeast (Figs. a and b). Most part of Bangladesh is dominated by the fertile Ganges Deltas, which is the largest river delta in the world. The northeast and southeastern- parts of the country are the home to evergreen hill ranges.

Bangladesh is called the "Land of rivers" as it is home to over 57 transboundary Rivers. This situation resolves water issues politically complicated. Bangladesh is frequently cited as one of the most vulnerable countries to climate changes because of its disadvantageous geographic location, flat and low-lying topography, and high population density, the reliance on many livelihoods or climate-sensitive sectors.

The climate of Bangladesh is subtropical in the center-north and tropical in the south. It is pleasantly warm and sunny in winter from November to February. Bangladesh faces- a short hot spring between March and May and a long rainy season from June to October. Monsoon ends in October but sometimes rains continue till the end of November because of cyclonic disturbances formed over Bangladesh and made landfall on the Bangladesh coast.

Fig 1: (a) Map of republic Bangladesh, (b) River flow over Bangladesh [Sources – Google].

The monsoon (Which is known as Southwest Monsoon or Summer Monsoon) arrives between late May and early June and starts to travel Bangladesh, from the southeastern part. It brings more compact cloudiness, high humidity even during the day, frequent rains, but also decreases in temperature. The rains are more abundant along the south coast, particularly in the southeastern part (Chittagong region). According to BMD (Bangladesh Meteorological Department) in 2020 monsoon onset over the whole of Bangladesh was on 12th June 2020. The actual precipitation of 2020 in Dhaka and Chittagong is as follows: In Chittagong, rains reach 7946 mm per year; here is the actual precipitation. In the whole year of 2020, there was around 111619 mm of rainfall, whereas, in the monsoon period, amount of rainfall recorded was 87922 mm. It was found that almost 79% of rainfall occurred in the monsoon period. In 2020, monsoon withdraws from Bangladesh on 31st October 2020.

Natural disasters in Bangladesh are floods, cyclones, storm surge, river erosion, earthquake, drought, salinity intrusion, fire, and tsunami. In the monsoon period, floods and landslides are common natural disasters. Flood is a perennial problem or recurrent event in Bangladesh. 80 percent of Bangladesh's rainfalls occurs in the monsoon season.

Table 1: Rainfall in Dhaka and Chittagong, Bangladesh

	Dhaka- Actual Precipitation in 2020			Chittagong Actual Precipitation 2020		
Month	Millimeters	Inches	Day	Millimeters	Inches	Day
January	157	6.18	6	538	21.18	4
February	6	0.24	4	51	2.01	1
March	144	5.67	6	67	2.64	0
April	956	37.64	16	2181	85.87	10
May	1912	75.28	18	3234	127.32	10
June	1865	73.55	15	6384	251.34	17
July	2213	87.13	15	7946	312.83	20
August	1353	53.27	18	7889	310.59	24
September	1345	52.95	10	4740	186.61	17
October	921	36.26	21	4122	162.28	15
November	89	3.50	8	545	21.46	4
December	0	0	0	0	0	0
The year 2020	10959	431.47	137	37697	1484.13	122

During the monsoon season, convectional rainfall of the monsoon is added to by relief rainfall caused by the Himalayas. Melt water from the Himalayas is also a significant input. During severe floods, the affected area may exceed 55 percent of the total areas of the country (Fig. 2). About 25 percent of the landmass is inundated with floodwater every year, causing extensive damage to human life and property. The most affected areas of flood in Bangladesh are Serajgonj, Gopalgonj, Kishoregonj, Bramanbaria, Rajbari, Faridpur, Madaripur, Jamalpur, Netrokona, Sunamganj Manikganj, Dhaka, etc

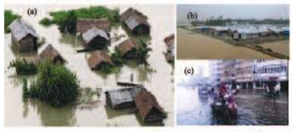


Fig. 2: (a) Houses underwater after flood, (b) Monsoon Floods wreak havoc in South Asia, (c) Flood in Bangladesh in 1988 [Sources- Google].

According to the report of the Bangladesh Ministry of Disaster Management and Relief (MoDMR), severe floods that struck Bangladesh during the last week of June 2020, which were prolonged and intensified with heavy monsoon and upstream water affected 5.4 million people in the north, central, and north-eastern parts of the country. Around 37 percent of the country's total areas were flooded affecting 33 districts. It was considered to be the longest flooding period in the last 22 years in the country. There were widespread damages in housing limitation of the access to clean and safe water. Access to livelihoods was observed in the most of affected districts as well.

RESEARCH AREAS AND FACILITIES

Solid State Physics

Biophysics, Medical Physics and Health Physics

Atmospheric Physics

ADMISSION/DEPARTMENTAL NEWS

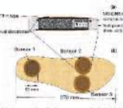
Department of Physics, BUET is a well-recognized seminary for studying postgraduate level Physics in Bangladesh. This Department offers M. Sc., M. Phil., and Ph. D. degree programs. Generally, students are admitted to these programs in either April or October postgraduate semester in every academic year. The admission notices are served on the website of BUET (http://pgadmission.buet.ac.bd). The admission details are also available on the website of Department of Physics (https://phy.buet.ac.bd).

ALUMNI NEWS

Spotlight

Dr. Md. Abdul Momin
Postdoctoral Researcher, Department of Mechanical System Engineering, Tohoku University, Japan

It is a suitable time to congratulate **Dr. Md. Abdul Momin**, alumnus of Department of Physics, BUET for starting his postdoctoral research. He was a student of the 1st Batch of M. Sc. (October 2014) in our department. He completed his M. Sc. degree under the supervision of Prof. Dr. Md. Abu Hashan Bhuiyan in June 2016. He achieved Japanese Government (MEXT) scholarship for Ph. D. program in October 2017. He successfully completed his Ph. D. degree from the Department of optoelectronics and nanostructure science, Shizuoka university, Japan in September 2020. During his doctoral research, he developed a smart shoe from MWCNT coated cotton fibers for monitoring of old man, human health, sports activities.



(Published in Journal of Nanomaterials, 2019, ID 7658437)

He is currently working on the fabrication of MEMS (Micro-Electro-Mechanical Systems) device, semiconducting sensor fabric and nano-mechanical gas sensors. He has recently developed a new kind of nanomechanical gas sensor for detecting hazardous gases and volatile materials.

Achievements

Md. Arif Ul Islam
Assistant Professor, University of Barisal, Bangladesh M. Sc., October 2014

Arif completed M. Sc. in June 2016 under the supervision of Prof. Dr. A. K. M. Akther Hossain. He has achieved Monbukagakusho Scholarship 2021 from Japanese Government for perusing his Ph. D. at Nagoya Institute of Technology, Japan.

Md. Majibul Haque Babu
Teaching Assistant, University of Texas at Austin, United States M. Sc., October 2015

Babu completed M. Sc. in May 2017 under the supervision of Prof. Jiban Podder. He is now a graduate student at the Department of Physics, University of Texas at Austin. His research underlies the topological insulator (TI) with the quantum Hall effect both theoretical and experimental for the quantum computer. Recently, he is trying to develop a Microwave Impedance Microscopy (MIM) which will be working below 30 cm in length at 1 GHz.

DEPARMENTAL EVENTS

Farewell program of a faculty member

Departmental annual tour

11th Convocation, 2019

Students working in different laboratories

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