

A BOOK ON HIMALAYAN ATMOSPHERIC AND SPACE PHYSICS RESEARCH LABORATORY

Department of Physics

Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar (Garhwal), Uttarakhand

Himalayan Atmospheric and Space Physics Research Laboratory Department of Physics, Hemvati Nandan Bahuguna Garhwal, University (A Central University) Srinagar Garhwal, Uttarakhand



The Himalayan Atmospheric and Space Physics Research Laboratory (HASPRL) is established at the Department of Physics, Chauras Campus, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India. We are conducting real-time ground based continuous observation of aerosol size distribution, aerosol & particulate matters concentration, gaseous pollutants, lighting activity and meteorological parameters. Our ultimate goal is to accurately measurements of aerosol, lightning & forest fire activity, air pollutants and meteorological parameters. We are also working on development of regional models for forecasting and early warning system of lightning, climate change & impacts of pollutants on human health over the Garhwal Himalayan region of Uttarakhand. This lab is established by the sponsoring Funding agencies of Government of India: Department of Science and Technology (DST) and Science and Engineering Research Board (SERB) and in collaboration with Indian Institute of Tropical Meteorology (IITM), Ministry of Earth Science, Government of India, Pune.

Sponsors and Collaborators:



सत्यमेव जयते Department of Science & Technology Govt. of India



Science and Engineering Research Board Department of Science and Technology Government of India, New Delhi



In-charge of the Himalayan Atmospheric and Space Physics Research Laboratory (HASPRL)

Dr. Alok Sagar Gautam



Research Scholars working in the Laboratory

- 1. Karan Singh
- 2. Sanjeev Kumar
- 3. Shyam Narayan Nautiyal
- 4. Aman Deep Vishwakarma
- 5. Yasti Panchbhaiya
- 6. Ajay Kumar













Karan Singh

Sanjeev Kumar Shyam Nautiyal

Amandeep Vishwakarma Yasti Panchbhaiya Ajay Kumar

1. Nano SMPS (TSI, 3910)

Principle: Electrical Mobility

This instrument is a portable device and measures the nanoparticle size distribution with particle concentrations. it measures the nanoparticles in 13 size-bins ranging from 10 to 420 nm. The first size bin is 11.5 nm in diameter, while the last size bin is 3652 nm. Nano SMPS runs in two modes (1) Scan mode and (2) Single mode. Concentration range is from 100 (10^2) to 1000000 (10^6) particles/cm³. It works in four steps:

Inlet conditioner (it removes large particles by D50 cutoff point of approximately 550 nm).
Unipolar Charger (In this, the corona needle- tip creates a jet of positive ions and collides with the incoming particles. Now the particles mix together and come into a uniformly charged state. This process takes place in a mixing chamber.)

(3) Radial Differential Mobility Analyser (Now the uniform charged particles enter in RDMA and experience an electric field that causes them to move through the gas in which they are suspended. By the mobility of particles RDMA measures the particle size.)

(4) Condensation Particle Counter (in this, particles grow by IPA and are counted one by one). The data is downloaded by using pen derive and Nano SMPS manager software which is installed in the lab computer.



Figure 1 NanoScan SMPS installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

This instrument is running from the year of 2020 to till now (2024) in the Himalyan Atmospheric and Space Physics Research Laboratory, Department of Physics, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India and it is sponsored by Department of Science and Technology (DST). This instrument was sponsored by Department of Science & Technology funded research project entitled "What impacts do aerosols have on cloud condensation nuclei, clouds and rainfall over a pristine Himalayan region" Department of Science & Technology, (SPLICE- Climate Change Programme) Ministry of Science & Technology, Government of India.

M.Sc. Dissertations: M.Sc dissertations were completed on the Nano SMPS instrument during the sessions 2021-22, 2022-23 and 2023-24.

2. SO₂ Analyser (Ecotech, Serinus 50)

Principle: Classical Florescence Spectroscopy Principle

So₂ exhibits a strong UV absorption spectrum between 200 to 240 nm (UV range = 100 nm to 400 nm and Visible Light range = 400 to 760 nm). When SO₂ absorbs UV at this wavelength, photon emission occurs (300 to 420 nm). The amount of fluorescence emitted is directly proportional to the SO₂ concentration. The SO₂ concentration we got in ppb and after measurement we convert this into μ g/m³ through multiply by 2.62. The data is downloaded by using already inserted USB pen derive or Airodis software installed in the lab computer. Figure 2 SO₂ analyser installed at the Himalyan Atmospheric and Space Physics Research Laboratory, HNBGU. This instrument is running from the year of 2018 to till now (2024) in the Atmospheric and Space Physics Laboratory, Department of Physics, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India and it is sponsored by Science and Engineering Research Board (SERB).

Publications: Gautam, A. S., Kumar, S., Gautam, S., Singh, K., Ram, K., Siingh, D., Ambade, B., & Sharma, M. (2023). Regional air quality: biomass burning impacts of SO2 emissions on air quality in the Himalayan region of Uttarakhand, India. Air Quality, Atmosphere & Health, 17(1), 1–18.

https://doi.org/10.1007/s11869-023-01426-



Figure 2 SO₂ analyser installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

No. of Publication: 1

Reports: Four progress reports were submitted in SERB during the period of this SERB project entitled "Formation mechanism and Characteristics of aerosols in different seasons and its impact on cloud formation processes and climate at Himalayan region Uttarakhand".

Book Chapters: Three book chapters has been published in the books "Recent Advancements in Sciences with Special Reference to Himalaya" and "Advancement in Basic and applied sciences" in the year of 2019 and 2020.

No. of Book Chapters: 3

Book Chapters References:

- Sanjeev Kumar, Alok Sagar Gautam, Abhishek Joshi, Karan Singh (2020). Study on Temporal and Spatial Variation of Sulfur Dioxide (SO2) Over Alaknanda Valley (Garhwal Himalayan Region) of Uttarakhand, India is Driven by Satellite Data. Recent Advancements in Sciences with Special Reference to Himalaya, 1-18, 978-93-84866-91-4.
- II. Alok Sagar Gautam, Sanjeev Kumar, Dipshikha Gusain, Karan Singh (2020). Short term Study on Temporal of Sulfur Dioxide (SO2) over Alaknanda Valley (Garhwal Himalayan Region) of Uttarakhand, India. Recent Advancements in Sciences with Special Reference to Himalaya, 95-122, 978-93-84866-91-4.
- III. Alok Sagar Gautam, Sanjeev Kumar, Karan Singh, Akash Kumar, Nidhi Gairola, Kaupo Komsaare (2019). Variation Concentration of Sulfur Dioxide and Correlation with Metrological Parameters over Alaknanda Valley, Garhwal Himalaya Uttarakhand. Advancement in Basic and applied sciences, 40-91, 978-93-84866-90-7.
- **M.Sc. Dissertations:** M.Sc dissertations were completed on the SO₂ analyser instrument during the sessions 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24.

3. Aethalometer (MAGEE SCIENTIFIC, AE33-7)

Principle: Light Attenuation

AE33 collects aerosol particles continuously by drawing the aerosol-laden air stream through a spot on the filter tape. We measure the transmission of light through one portion of the filter tape containing the sample, versus unloaded portion of the filter tape acting as a reference area for the analysis of aerosol. This analysis is done at seven wavelengths spanning the range from the near-infrared to the near-ultraviolet. The Aethalometer calculates the instantaneous concentration of optically-absorbing aerosols from the rate of change of the attenuation of light transmitted through the particle-laden filter.

$$BC = \frac{b_{abs}}{\sigma_{air}}$$

Here, b_{abs} is light absorption coefficient (which measures by light attenuation coefficient) and air is mass absorption cross-section. In the AE33 data, we take 6th channel (measurement at 880 nm) data for black carbon concentration. Here, the first channel is measured at 370 nm, while the last channel is measured at 950 nm. The Data is downloaded by USB pen derive.



Figure 3 Athalometer (AE33-7) installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

This instrument is running from the year of 2018 to till now (2024) in the Himalayan Atmospheric and Space Physics Research Laboratory, Department of Physics, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India and it is working in collaboration with Indian Institute of Tropical Meteorology (IITM), Pune. Publications: Four research papers has been published entitled "Black carbon over a central Himalayan Glacier (Satopanth): Pathways and direct radiative impacts", "Observations of black carbon and albedo over a Central Himalayan Glacier (Satopanth): Preliminary results", "Black carbon over a high altitude Central Himalayan Glacier: Variability, transport, and radiative impacts" and "Black Carbon Characteristics over a Semi-urban Environment in the Garhwal Himalayas" in the Journal of Science of The Total Environment (2020), Journal of Atmospheric and Solar-Terrestrial Physics (2021),

Environmental Research (2021), and Pure and Applied Geophysics (2023) respectively.

No. of Publication: 4

References:

I. Panicker, A., Sandeep, K., Gautam, A. S., Trimbake, H., Nainwal, H., Beig, G., Bisht, D., & Das, S. (2021). Black carbon over a central Himalayan Glacier (Satopanth): Pathways and direct radiative impacts. Science of the Total Environment, 766, 144242.

.https://doi.org/10.1016/j.scitotenv.2020.144242

II. Sandeep, K., Panicker, A., Gautam, A. S., Safai, P., Beig, G., Nainwal, H., Bisht, D., & Das, S. (2021). Observations of black carbon and albedo over a Central Himalayan Glacier (Satopanth): Preliminary results. Journal of Atmospheric and Solar-terrestrial Physics, 216, 105580.

https://doi.org/10.1016/j.jastp.2021.105580

III. Sandeep, K., Panicker, A., Gautam, A. S., Beig, G., Gandhi, N., S, S., Shankar, R., & Nainwal, H. 2022). Black carbon over a high altitude Central Himalayan Glacier: Variability, transport, and radiative impacts. Environmental Research, 204, 112017.

https://doi.org/10.1016/j.envres.2021.112017

IV. Panicker, A. S., Sandeep, K., Gautam, A. S., Kumar, S., Beig, G., Latha, R., & Murthy, B. S. (2023). Black Carbon Characteristics over a Semi-urban Environment in the Garhwal Himalayas. Pure and Applied Geophysics, 180(7), 2879–2888.

https://doi.org/10.1007/s00024-023-03311-0

Reports: Many news have been published in the local news papers of Srinagar Garhwal for the awareness of local peoples.

4. Lightning Location Network (LLN) Sensor:

Lightning sensors were manufactured by the Earth Network. This network detects CG lightning in the frequency range of 1 kHz to 1 MHz. with 90% detection. IC lightning in the frequency range of 1–12 MHz with 50% detection efficiency, and location accuracy of 300 m. The total lightning for four years (December 2018–November 2022) detected by IITMLLN was counted at each $0.25^{\circ} \times 0.25^{\circ}$ grid. Then the IC:CG ratios (Z ratios) are calculated over India in each $0.25^{\circ} \times 0.25^{\circ}$ grid considering the detection efficiency using the relation: *ZZ* ratio = (NIC/ddIC)/(NCG/DCG)where NIC and NCG represent the total number of IC lightning flashes and CG lightning flashes respectively.

Whereas dIC and dCG denote the detection efficiency of IC and CG lightning flash over India, respectively. This instrument is running from the year of 2018 to till now (2024) in the Himalayan Atmospheric and Space Physics Laboratory, Department of Physics, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India and collaboration with IITM Pune.



Figure 4 LLN Sensor installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

No. of Book Chapters: 1

Book Chapters References:

I. Ankit Nautiyal, Alok Sagar Gautam, Penki Ramesh Kumar and Dr. Roopesh Kumar (2020). Lightning and Climate Change in Srinagar Garhwal. Recent Advancements in Sciences with Special Reference to Himalaya, 81-95, 978-93-84866-91-4.

M.Sc Dissertations: M.Sc Dissertation were completed on the Lightning sensor during the session 2021-22, 2022-23, 2023-24.

5. Automatic Weather Station (AWS, Davis Vantage pro - 2)

To monitor the meteorological parameters (MPs) humidity (%), temperature (°C), wind direction (°), wind speed (m s⁻¹), solar radiation (W m⁻²), and rainfall (mm), an Automatic Weather Station (AWS) was installed in the Himalayan Atmospheric and Space Physics Research Laboratory, Department of Physics, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India and it is sponsored by SERB, New Delhi. This instrument is running from the year of 2018 to till now (2024).

AWS is a customizable weather station with a wide range of options and sensors to measure, monitor, and record weather data. The MPs data were extracted at an interval of one minute that further converted into hourly basis to visualize the results.



Figure 5 AWS, Virtual Davis Vantage pro - 2 installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

High accuracy relative humidity and temperature sensors were also used in the AWS to measure the relative humidity and temperature, while an Anemometer and Pyranometer were also utilized to capture the wind parameters and solar radiation, respectively. An anemometer is a wind-speed and direction measurement device. Pyranometer sensor is a type of actinometer which based upon the simple concept determines the number of photons in a beam integrally or per unit time used to measure solar irradiance on a flat surface and is manufactured to measure the solar radiation flux density (W m⁻²) from the hemisphere above within a wavelength range of $0.3-3 \mu m$.

Publications: Many research papers have been published during 2018 to till now (2024) on this instrument as supportive data.

Reports: Many reports have been published during 2018 to till now (2024) on this instrument as supportive data.

Book Chapters: Many book chapters have been published during 2018 to till now (2024) on this instrument as supportive data.

M.Sc. Dissertations: M.Sc dissertations were completed using the AWS data during the sessions 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24.

6. Automatic Weather Station (AWS, Virtual Hydromet)

One another AWS is installed in the Himalayan Atmospheric and Space Physics Research Laboratory, Department of Physics, Hemvati Nandan Bahuguna Garhwal University (A Central University), Srinagar Garhwal, Uttarakhand, India and it is sponsored by DST, New Delhi. This instrument is working from the year of 2018 to till now (2024). The meteorological parameters (MPs) temperature (°C), relative humidity (%), wind direction (°), wind speed (m s⁻¹), solar radiation (W m⁻²), barometric pressor (mb), soil temperature (C), soil moisture (cb) and rainfall (mm) measure this AWS. The MPs data were extracted at an interval of one minute that further converted into hourly basis to visualize the results.



Figure 6 AWS, Virtual Hydromet installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

High accuracy relative humidity and temperature sensors were also used in the AWS to measure the relative humidity and temperature, while an Anemometer and Pyranometer were also utilized to capture the wind parameters and solar radiation, respectively. An anemometer is a wind-speed and direction measurement device. Pyranometer sensor is a type of actinometer which based upon the simple concept determines the number of photons in a beam integrally or per unit time used to measure solar irradiance on a flat surface and is manufactured to measure the solar radiation flux density (W m⁻²) from the hemisphere above within a wavelength range of $0.3-3 \mu m$.

Publications: Many research papers have been published during 2018 to till now (2024) on this instrument as supportive data.

Reports: Many reports have been published during 2018 to till now (2024) on this instrument as supportive data.

Book Chapters: Many book chapters have been published during 2018 to till now (2024) on this instrument as supportive data.

M.Sc. Dissertations: M.Sc dissertations were completed using the AWS data during the sessions 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24.

7. HP Z2 Tower G9 Workstation

Specifications:

The HP Z2 Tower G9 is installed in year of 2024, features a 13th Gen Intel® CoreTM i7-13700 processor, 16 GB RAM, dual 1 TB hard drives, Intel® UHD Graphics with 8 GB, and NVIDIA GeForce RTX 360 with 12 GB, making it ideal for high-performance computing tasks.



Figure 7 HPZ2 Tower G9 Workstation installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

Working Steps:

- 1. Data Collection: Ingest vast datasets from satellite imagery, weather stations, and AWS.
- 2. Preprocessing: Clean and format data for model training using the workstation's robust storage and memory.
- 3. Model Training: Utilize the powerful processor and dual GPUs to train AI/ML models, including Support Vector Machines (SVM), Random Forests, Convolutional Neural Networks (CNNs) for image recognition, and Recurrent Neural Networks (RNNs) for time series forecasting.
- 4. Real-Time Analysis: Analyze incoming data in real time to predict extreme weather events, leveraging the dual-GPU setup for quick computation.
- 5. Prediction: Generate and disseminate accurate forecasts and early warnings for events such as hurricanes, floods, and cloudbursts.
- 6. Post-Event Analysis: Assess the impact and refine models based on actual event data to improve future prediction accuracy.

Book Chapters: One book chapter is in progress entitled "Study of Extreme Weather Events in the Central Himalayan Region through Machine Learning and Artificial Intelligence: A Review" in TAYLOR & FRANCIS GROUP.

8. PM_{2.5}Sampler: (Envirotech, APM 550)

Working Principle: The APM 550 system is a manual method for sampling fine particles (PM2.5 fraction) and is based on impactor designs standardized by USEPA for ambient air quality monitoring. Ambient air enters the APM 550 system through an omni-directional inlet designed to provide a clean aerodynamic cut -point for particles greater than 10 microns. Particles in the air stream finer than 10 microns proceed to a second impactor that has an aerodynamic cut point at 2.5 microns. The air sample and fine particulate exiting from the PM2.5 impactor are passed through a 47mm diameter Teflon filter membrane that retains the FPM. The sampling rate of the system is held constant at 1m³/hour by a suitable critical orifice. By locating all power dissipating components in a separate cabinet, the APM 550 ensures that the temperature of the PM 2.5 filter remains close to ambient temperature and there is no chance of losing volatile fractions of the PM 2.5. The system uses a continuous rated, oil free pump for providing suction pressure. The standard system is supplied with a Dry Gas Meter to provide a direct measure of the total air volume sampled.



Figure 8 PM_{2.5} Sampler Workstation installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU **Publications:** One research paper published entitled: Chemical Characteristics of Atmospheric Aerosol at Alaknanda Valley (Srinagar) in the Central Himalaya Region, India (2018).

No. of Publications: 2

References:

I.Gautam, A. S., Negi, R. S., Singh, S., Srivastava, A. K., Tiwari, S., & Bisht, D. S. (2018). Chemical characteristics of atmospheric aerosol at Alaknanda Valley (Srinagar) in the Central Himalaya region, India. International Journal of Environmental Research, 12(5), 681–691.

https://doi.org/10.1007/s41742-018-0125-8

II.Panicker, A. S., Sandeep, K., Negi, R. S., Gautam, A. S., Bisht, D. S., Beig, G., Murthy, B. S., Latha, R., Singh, S., & Das, S. (2019). Estimates of Carbonaceous Aerosol Radiative Forcing over a Semiurban Environment in Garhwal Himalayas. Pure and Applied Geophysics, 176(11), 5069–5078.

. https://doi.org/10.1007/s00024-019-02248-7

Reports: Many reports have been published during 2018 to till now (2024) on this instrument in newspapers.

Book Chapter: One book chapter published entitled: A review on chemical characterization on particulate matter over central Himalayan region, Uttarakhand, India.

No. of Book Chapters: 1

Book Chapters References:

I.Shyam Narayan Nautiyal, Veena Joshi, Alok Sagar Gautam, Sanjeev Kumar, Karan Singh (2024). A review on chemical characterization on particulate matter over central Himalayan region, Uttarakhand, India. Holistic Connections: A Multidisciplinary Approach to Yogic Science, Education and Climate Change, 978-81-971646-3-7.

M.Sc Dissertation: M.Sc dissertations were completed using the AWS data during the sessions 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24.

9. PM₁₀ Sampler: (Envirotech, APM 460)

Working Principle: The APM 460 is used for routine monitoring of PM 10 in the ambient air. By using the APM 460, measurement of Respirable Particulate Matter can be done accurately and TSPM can also be assessed by collection of dust retained in the cyclone cup. The APM 460 gained acceptability from academic institutes consultants and a wide spectrum of industries besides country-wide use by the Pollution Control Boards and the National Ambient Air Monitoring Program. The APM 460 sampler uses an improved cyclone with sharper cutoff (D50 at 10 microns) to separate the coarser particulates from the air stream before filtering it on the glass microfibre filter (CSIR NEERI knowhow). APM 460 comes with a brushless, continuous rated induction motor to significantly reduce equipment downtime, maintenance efforts and inconvenience to community. The brushless blower of the APM 460 also substantially reduces the audible noise. A thermal cut-out has been incorporated to protect the Blower motor from burnout due to overheating. With the improved motor design, the instrument no longer needs a voltage stabilizer resulting in cost saving and lowering the weight of the field instrument. The cabinet design has been improved to prevent entry of rainwater and dust into the machine.



Figure 9 PM₁₀ Sampler Workstation installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

No. of Publications: 2

References:

I. Gautam, A. S., Negi, R. S., Singh, S., Srivastava, A. K., Tiwari, S., & Bisht, D. S. (2018). Chemical characteristics of atmospheric aerosol at Alaknanda Valley (Srinagar) in the Central Himalaya region, India. International Journal of Environmental Research, 12(5), 681–691.

. https://doi.org/10.1007/s41742-018-0125-8

II. Panicker, A. S., Sandeep, K., Negi, R. S., Gautam, A. S., Bisht, D. S., Beig, G., Murthy, B. S., Latha, R., Singh, S., & Das, S. (2019). Estimates of Carbonaceous Aerosol Radiative Forcing over a Semiurban Environment in Garhwal Himalayas. Pure and Applied Geophysics, 176(11), 5069-5078.

. https://doi.org/10.1007/s00024-019-02248-7

Reports: Many reports have been published during 2018 to till now (2024) on this instrument in newspapers.

Book Chapter: One book chapter published entitled: A review on chemical characterization on particulate matter over central Himalayan region, Uttarakhand, India.

No. of Book Chapters: 1

Book Chapters References:

I. Shyam Narayan Nautiyal, Veena Joshi, Alok Sagar Gautam, Sanjeev Kumar, Karan Singh (2024). A review on chemical characterization on particulate matter over central Himalayan region, Uttarakhand, India. Holistic Connections: A Multidisciplinary Approach to Yogic Science, Education and Climate Change, 978-81-971646-3-7.

10. Conductivity Meter: (Elite, Dept. of Chemistry, SRT Campus, HNBGU)



Figure 10 Conductivity Meter available at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU Working Principle:

It involves applying a voltage between two electrodes immersed in the solution. The resulting current that flows through the solution is directly proportional to the solution's conductivity. This relationship is based on Ohm's Law, which states that the current (I) flowing through a conductor is directly proportional to the voltage (V) applied across it and inversely proportional to the resistance (R) of the conductor: I=V/RFigure 10 Conductivity Meter available at the Atmospheric and Space Physics Laboratory, HNBGU. In the context of a conductivity meter, the resistance is related to the ionic content of the solution. The more ions present, the higher the conductivity, as ions are the charge carriers that facilitate the flow of current.

11. pH Meter: (Aquasol)



Figure 11 pH Meter available at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU Working Principle:

It measures the voltage between the two electrodes, one is a glass electrode, and the other is a reference electrode. Sometimes, if both electrons are present, it is called the combination electrode, and they are inserted into the solution in which pH is to be tested, after immersing these electrodes in a solution, the H^+ ion in the test solution was exchanged for other positively charged hydrogen ions present on the glass ball. So, there is an action between these H^+ ions of the solution and the H^+ ions or positively charged ions present in the glass bulb. The amplifier detects the difference in electric potential between the two electrodes. The contrast of these potentials is called the ph unit.

12. Analytical Balance: (AS 82/220.X2 PLUS)

Maximum capacity [Max]: 82 / 220 g Readability [d]: 0,01 / 0,1 mg.



Figure 12 Analytical Balance installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

13. Double Distillation Unit: (5000 ml)

To separate a mixture of liquids, the liquid can be heated to force components, which have different boiling points, into the gas phase. The gas is then condensed back into liquid form and collected. Repeating the process on the collected liquid to improve the purity of the product is double distillation.



Figure 13 Double Distillation Unit installed at the Himalayan Atmospheric and Space Physics Research Laboratory, HNBGU

Contact us :

aplsrinagar@gmail.com/ phyalok@gmail.com or WhatsApp no. +91-9997138763 (Dr. Alok Sagar Gautam) WhatsApp no. +91-7895265238 (Mr. Sanjeev Kumar, RS) WhatsApp no. +91-7060820066 (Mr. Karan Singh, RS) WhatsApp no. +91-8869062901 (Mr. Shyam Nautiyal, RS) WhatsApp no. +91-9528134675 (Mr. Amandeep Vishwakarma, RS) WhatsApp no. +91-9528134675 (Ms. Yasti Punchbhaiya, RS) Webpage: https://www.hnbgu.ac.in/index.php/school/science/physics/srinagar/research



क्षुद्र ग्रहों की खोज करेंगे

गढवाल विवि के छात्र संवाद न्यूज एजेंसी

अंतरराष्ट्रीय खगोलीय खोज सहयोग कार्यक्रम में पांच छात्रों का चयन झीनगर। पड़पाल केंद्रोध विक्रमण के और

1 जुड्ला केर्द्रेण किया में प्राणा केरायुक्तम पाया का स्वाप्ता के स्वाप्ता केरा के स्वाप्ता के स्वार के स्वाया के क्वाया के स्वाया क

गढवाल विवि को मिली सफलता श्रीनगर सिंवाददाता

प्रारंभिक क्षुद्रग्रह की खोज में

हेमयती नंदन बहुनुणा गढ़वाल केंद्रीय विवि के भीतिक विज्ञान विभाग की टोम को नसा प्रार्थिभक बुद्रप्रग्न (ऐस्टेर्यायड) की खोज में सफलता हासिल हुई है। टीम की चार खोजों की रिपोर्ट में

जाना है। महत्वाल विश्वविद्यालय के भौतिक विद्यान विभाग के डा. आलंक सागर गौरान ने बलाया कि प्रान्धेय वैमानिकी और अंतरिक्ष प्रवंधन (न्यारा) को साहेवरानी में रसेस नेवेरिका एडवाडतों कारोंसल (एसजीएसी) और अंतरराष्ट्रीय बवोलीय खेंज सहयोग कार्जनम ने ज्यानेयारे सहयोग कार्जनम ने

टीम को चार सोठों को गिर्देर में व्यग्तिये कोंग साइसेम फार्कम में सुरा क से प्रार्थिक प्रहार कोंग के प्रारंभ क्यार राज्या राज का काम में अंतर्गाष्ट्रीय व्यवशीय सारवेग विश्वम का द्वार्थक के द्वारा स्वीच्या कार्यक्रम (आतीलक) द्वारा स्वीच्या कार्यक्रम (आतीलक) द्वारा से स्वीच्य संवी, अबहरस सोज पर प्रात्मन करेट संटर (अंतरराष्ट्रीय कार्यजीव करीक प्राण टेलीस्सोम देव का संस, परिता हाय अगरेक शोध किया विश्वमेष्ठ की







क्षुद्र ग्रहों की खोज करेंगे पांच छात्र

गढ़वाल विवि के पांच छात्र नासा की ओर से संचालित अभियान में चयनित



त्वा होते हैं कुछ बह रस की संझुट पर गढ़वल बिंटि का नाम





भोतिक विज्ञान PHYSICS

नासा के प्रोजेक्ट से जुड़े गढ़वाल विवि के पांच छात्र उपलब्धि क्या होते है क्षुद्रग्रह रिसर्च

श्रीनगर | संवाददाता

हेमशती नरंत बातुगुण गढुवाल केंद्रीय विवि के भौतिको विषया से जुड़े पांच छात्र बुझ छतें की खोज से जुड़े पफ अंतर्गवर्टम प्रजीसक से काम कर रहे हैं। इन छात्रों का चयन नासा समर्थित अंतरप्रदृषि छनौलीय खोज सहलोग कार्यक्रम से बुझडातें (एस्टेर्रायड) की खोज करने के लिए

 भौतिकी विभाग के छात्र नासा से जुड़े प्रोजेक्ट में कर रहे हैं काम
एस्टेरॉयड सर्च कैम्पेन में हुआ है छात्रों का चयन

हुआ है। नासा का यह कार्यक्रम संयुक्त राष्ट्र संघ के सारवंग से संयालित स्पेस जेनेरेशन एडवाइजर काउसिल ने सुरू किया है, जो 26 नवस्बर तक होगा। इस प्रोजेक्ट में जरी हेमवती नंदन बहुगुणा गढ़वाल

विश्वविद्यालय के शोध छात्र संजीव विश्वविद्यालय के शांध छात्र सजाव कुमार और कर्ण सिंह, भौतिकों के परास्तारक छात्र महावीर प्रसाद, शिवानी कुल्सार और स्तातक छात्र प्रवीण कुमार को शामिल किया गया है। वरिष्ठ भौतिक वैज्ञानिक डॉ.

पदा िशा ि सुद्रिश्रम् व धायुहीन सहस्य हे जो सूर्य की परिक्रमा करते हैं । सुद्रारा अंतरिक्ष के प्रदानी व धायुहीन सहस्य हे जो सूर्य की ककाओं के मत्य अंतर के आकार का विशाल सुद्रारा स्तरा है । जिसे मुख्य सुरारा बेटर काल जाता है । यहा सुरारा के कातों की संख्या में प्लररर मंग्रह है । पूर्यों के करीब के सुद्रारहों की नियर-अर्थ अंजिंकर या नीओ कहा जाता है । आलोक सागर गीतम के निर्देशन आलाक सागर गौतम के निदेशन पांचों छात्र पृथ्वी के पास स्थित नियर-अर्थ ऑड्येक्ट और मंगल च बुहारपति हाह के मध्य स्थित शुप्रप्रात्रों को खोज कर रहे हैं। यरिष्ठ भौतिक वैज्ञानिक डॉ. गौतम ने बताया कि

विश्वविद्यालय के भौतिक विज्ञान विश्वापक छात्रों का भवन होंग गाँव की बात है। कहा हमारे छात्र विश्वप्यटल पर की की स्वर्थात कर संकरें। इस प्रकार की गतिविभिष्यां बिदावियों को भौविष्य में खगोल भौतिकों और देव आयोरत होय के लिए प्रेरित करेंगी। उन्होंने बातवाकि गृदवाना स्वियविद्यालय को दोन खगोल विद्यान संस्थात (हर्वा विवि) को देन-स्टार्स टेलिस्कोप से प्राप्त खगोली के दोने से पर स्टोंग कर खुटहारों की खोज करेंगी।



(19)



अमरउजाला

4 अलकनंदा घाटी में जंगलों में आग लगने से 13 गुना बढ़ा ब्लैक कार्बन एवएनी प्रयान विवर्धपालय के भीतिवी विभाग के हुए संबर्ध, म्लेसिकों और मैंव विविध्यत के लिए कालाक लोक पार्बन में व्योकी < Hilling
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Media Highlights



एलएलएन सेंसर ने काम करना किया शुरू

बिजली गिरने की मिलने लगी जानकारी मा साल मुने

गढ़वाल जागरण

आकाशीय बिजली का लगगा पूर्वानुमान जगरण संतादता, श्रीनगर गढवलः गढ्वल क्षेत्र में अकाशीव कर्त्राय विस्वविद्याल के भौकि के देवी भौकि विद्यान दिव्यन एतले ही पता चल सर्कना । गढ्वल फले ही पता चल सर्कना । गढ्वल कर्त्राय विस्वविद्याल के भौकि के देवी भौकि विद्यान विभाग के जंगल श्रीय में आजाशीव के देवी विभीक के देवी भौकि विद्यान विभाग के जंगल श्रीय में आजाशीव के जंगल श्रीय में आजाशीव

के प्रथा वाक्यवावधाल के भातिक. के इर्ष रावाव भातिक विज्ञान विभाग । बकला गारा था थि, गातन ने करा विज्ञान विभाग के चौरास परिसर के सहायक प्रोफेसर डॉ. आलोक कि भारतीय मौसम विज्ञान संस्थान रिखत लैब में इक्के लिए लाइटनिंग आगर गौस में ते बेने में स्थापित इसी पूर्ण ये का इंग्रे द्वीत्रक डॉ. मुर्गान डिटेक्शन नेटवर्क ने कार्य करना नेटवर्क के माध्यम से बीते वे दिन में प्रवेश कर सहयोग से इस प्रोजेक्ट का शुरू कर दिवा है। भारतीय ऊष्ण हुई बारिज के दौरान बिजली गिरने संचालन किया जा खा है।

जा सकता है कि किस क्षेत्र में आकाशीय बिजली गिरने की संभावना है। इसको सूचना ऐप द्वारा लगभग डेड घंटे पहले मिल आएगी।



अभ्य अध्यात्रका ज्यादात्र छात्रों ने किए तीन हजार बीज बम तैयार छुलपति के निर्देश पर पृथ्वी दिवस सराहा में भौतिक दिवान विभाग की अनुवी पहल जन्म बिल बिला कर की

Quelling On (Hige) परं साला Gaosan Gener Asian पुराला केंद्रे स्वत्ये क्रियान के प्रियान केंद्र स्वत्यों केंद्रियान के विद्यार पर क्रियां क्रियान के तिक्षा रहा गित स्वार के स्वत्ये के स्वारं के यहां क्रियान के स्वत्ये के स्वारं के यहां क्रियान के स्वत्ये के स्वारंत के यहां क्रियान के स्वत्ये के स्वारंत के यहां क्रियान के स्वत्ये के स्वारंत के के क्रियान के स्वत्ये के स्वारंत के के क्रियान के स्वत्ये के स्वारंत के का क्रियान के स्वत्ये के स्वारंत के स्वारंत क्रियान के स्वारंत के स्वारंत के स्वारंत के स्वारंत के का क्रियान के स्वारंत के स्वा

सा जीवस परिसद से लागना पांच के दिस्टे पूर प्रेश्वलेट से सामेग से सा पूरिय की पीकॉरेटर कर राजवाट सारों की बाजीरेटर कर राजवाट कर की है। गड़बल केहीय जिने के सीचिक में क्यांने कर सार सीना के सीचिक वालीक सार सीना के सीचिक का बालीक सार सीना के सीचिक का में सुसरका की सिक्वीकसाएं के स्थ The second secon



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ियाने कहाकि कालगुरुपाले प्राप्त प्राप्तक थे, प्रियम कहा कालगुरुपाले प्राप्त कहा किलिए के प्राप्त के प्राप्त के प्राप्त कालगुरुपाले का किलिए के प्राप्त कहा किला की सुरक्ष कही कि जिनकों प्राप्त के कहा का जात किला की सुरक्ष कही है, जिनकों प्राप्त के कहा का जात भा अस्थान सामग्रिक से प्रथम आग प्रथम जिन्दी : सामित्रत प्रतिकेति के प्रथम अपने किंग्रे : प्रतिकार प्रिकेत के प्रतिकेत अपने किंग्रे के प्रतिकेत किंग्रे के प्रतिकेत के प्रतिकेत किंग्रे के प्रतिकेत के प्रतिकेत किंग्रे के प्रतिकेत के प्रतिकेत



















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गढवाल केंद्रीय विश्वविद्यालय में पृथ्वी दिवस सप्ताह कार्यक्रम संपन्न s.!

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र वे आहुता। सिहता किस्ता के ता, त्यावस्वया। साम स्वय ति सीमस्ता नेदिस्ता, तिम्प्रसार क्रियम, के ते को क हिंदी स्वया से देखें सिंध की स्वयम, करन साथ दिव को सनिया से प्रत्या के बात का साथ का से रहा क वे सिंधना के स्वया के दिव यहा। व सिंदिया सीम्प्रसार की दिव यहा।

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विवि के खाते में एक और उपलब्धि हुई दर्ज,इस टाइल के दवाव से सौर पैनल की वैटरी भी की सकती है चार्ज

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वायु मंडल में एरोसोल का माप और भारत में उसकी स्थिति विषय पर कार्यशाला



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group) under the supervi senior physicist Alok. Gautaru, are participating cover main-belt asteroo near-earth objects. The G University team will atte discover asteroids by ana mpt to Dimensional discover asteroids by anaryses-astronomical data images received from the Pan-STARRS Telescope of the Institute of Telescope of the Institute of ATMOSPHERIC AND SPACE PHYSICS LABORATORY (DST AND SERB FUNDED PROJECTS)

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