Research training course on **"Atomic and Molecular Astrophysics and Spectroscopy with computational workshops on the R-matrix, SUPERSTRUCTURE codes"** under the Indo-US APJ Abdul Kalam STEM Education and Research Center of Ohio State University (OSU)-Aligarh Muslim University (AMU), by Prof. Sultana N. Nahar (Email: nahar.1@osu.edu) jointly with Prof. Anil K. Pradhan (AKP, pradhan.1@osu.edu), Dept of Astronomy, OSU, USA

- Lectures & Workshops: 4 weeks, Saturdays & Sundays, 3 hours/session, May 4 - 30, 2024
- Venue: online zoom platform. Time: 11 am - 2 pm, US Eastern time
- Computational Facility (online): Ohio Supercomputer Center (OSC), USA

Course certificates (completion/participation w/o exam) will be provided, participation is free

- Textbook: "Atomic Astrophysics and Spectroscopy" -By A.K. Pradhan and S.N. Nahar (Cambridge University Press, 2011)
- Contacts: Prof. Tauheed Ahmad, Director, Indo-US STEM Education and Research Center, AMU, India Email: ahmadtauheed@rediffmail.com, Mobile: 91-8279632366, 9837404077

<u>SYLLABUS</u>

Week 1 (May 4,5, 2024): *Plasma, Atomic Structure, Computational Workshop*

i) Light and Matter, Plasma Sources, Particle and Photon Distributions, Overview on Applications (AKP): Chemical abundances, exoplanetary atmospheres, opacities, nano-biomedical X-rays. etc.

ii) Atomic Structure: Hydrogenic & Non-Hydrogenic Spectra

iii) Hartree-Fock, Dirac, Breit-Pauli Approximations

iv) Computational Workshop: SUPERSTRUCTURE

Week 2 (May 11,12): *Radiative & Collision processes, Computational Workshop*

i) Atomic Process in Plasmas - Radiative Transitions, Electron-Impact Excitation (EIE),

ii) Photoionization, Electron-Ion Recombination

iii) Close-Coupling Approximation and R-matrix Method

iv) Computational Workshop: SUPERSTRUCTURE

Week 3 (May 18,19 2024): *Computational Workshop on EIE using R-matrix codes, Molecular Structure & Spectra*

i) Electron-Impact Excitation
ii) Line Ratios for Plasma Diagnostics
iii) Computational Workshop: R-matrix Calculations for EIE
iv) Prof. Pradhan lecture: Molecular Structure and Astrophysical Spectra

Week 4 (May 25,26, 2024): *Astrophysical Applications, Exam, Certificate*

Prof. Anil Pradhan's lectures: i) Plasma modelling and Plasma opacity
ii) Review of materials
iii) Exam and evaluation
iv) Preparation and distribution of Certificates by May 30, 2024
NOTE: Computational workshops on R-matirx method are divided in two parts
- Part I: Collisional excitation and Part II: radiative processes
• Present form: Part I: Focus will be on Electron Impact Excitation

GLOBAL PARTICIPATION REGISTRATION:

• To enroll, email the following information (the way you want for the certificate)

Full official name:
Designation (Prof, Dr., Researcher, Student with current status of education):
Name of the affiliated University or Institution:
City and country names:
Email:

• zoom link for the sessions:
https://osu.zoom.us/my/snnahar?pwd=TkJvNnptTzRQSEZ4c3RWNzBDV2pSZz09
Personal meeting id: 665 664 7991, pw: 330775

• Please create your account at Ohio Supercomputer Center (OSC) following the instructions in the next pages. Note: OSC will provide a new access code.

Get your account at Ohio Supercomputer Center (OSC)

For the computational workshops, you will need an account at OSC. Please follow the steps below from the weblink

- https://www.osc.edu/supercomputing/portals/client_portal/self_signup_for_account
- Click on blue highlighted link "MyOSC" right below "Self-Signup for Accounts

It will open up to a window for "log in" and "Sign-up". For new account click on "Sign-up" which will open up "Your Contact Information" page

Enter your information (Red asterisk boxes).

If you do not have institutional email address, put down the email address that you have. Click on the "Submission" bar.

OSC will send you an email with a code to verify your email address and open a window to type that code. So check your email to get the code and put it in the box "Enter your Code here". - Click in the box "I'm not a robot". You get a CAPTCHA image to click on boxes

This will go to the next page with you will enter your access code:
- Project code: PAS1866
- Access code: 635858

NOTE: We will recieve a new access code on May 14.

• To login to your account, you will go to the same page of "myosc portal". Please remember to use Project code and the Access

• To log in to you account from a "terminal window". Follow as:
- Type: ssh YourID@owens.osc.edu (ssh app could already be in your computer)
- or: ssh -o serveraliveinterval=60 YourID@owens.osc.edu

The option "-o serveraliveinterval=60" lets you stay logged in for a longer time.

Please note that after typing each command, you will hit the <return> key

Log in to you OSC account for running jobs

For the computational workshops, you will need a terminal window where you can write commands for viewing and editing files, submitting and running programs. You can use any of the following terminals:

- i) The terminal window that exists in your computer
- ii) Download from the internet "Putty" which creates a terminal window to log in to a remote host
- iii) use the terminal window that OSC provides from "onDemand" log in page. For the OSC terminal, please follow the steps below:

• On the internet, go to: https://ondemand.osc.edu

• Click on "OSC OnDemand - Ohio Supercomputer Center"

- OSC log in page will open up.

• Type in your user name and password and click on the bar stating "Log in with your OSC account"

- You will be led to your account page

• From the top blue bar, click on the "Clusters" and drag your cursor to "Owens shell access".

- This will take you to the terminal window to work (black background)

• Work on your programs: copying, running, check the input output files etc.

• When done with your work, go to the previous page by clicking on the "Dashboard OSC" box at the top bar of your browser

• On the right of the top bar on you account page, you will find "log out" to click and get out.

• For any issue, contact OSC at: oschelp@osc.edu

Can also communicate to Heidi Hamblin at: hhamblin@osc.edu