IAUS 371

Honoring Charlotte Moore Sitterly: Astronomical spectroscopy in the 21st century

Schedule of sessions as of 2022-08-09

Tuesday, August 9

Plenary session		**Country**	**Type**
Turning Chaos into Order: The Life and Work of Charlotte Moore Sitterly	David Devorkin (M)	USA	Invited
The Legacy of Charlotte Moore Sitterly in the Internet Age	Alexander Kramida (M)	USA	Invited

Tuesday morning	**August 9, 2022**		
Molecular processes relevant for astrophysics: theoretical studies	Ewine van Dishoek (F)	Netherlands	Invited
Collisional excitation of molecules	Alexandre Faure (M)	France	Invited
Atomic calculations for astrophysics	Madeleine Burheim (F)	Sweden	Invited

Tuesday afternoon 1			
Keynote: Databases of atomic and molecular data	Marie-Lise Dubernet (F)	France	Invited
LIDA: The Leiden Ice Database for Astrochemistry	Will Rocha (M)	Netherlands	Contributed
NIST-LANL Lanthanide Opacity Database	Yuri Ralchenko (M)	USA	Contributed

Tuesday afternoon 2			
Keynote The state of solar analyses, and solar and stellar spectroscopy and solar models	Maria Bergeman (F)	Germany	Invited
Improving planetary atmosphere characterization by 3D NLTE modeling of the stellar centre-to-limb effect	Gloria Canocchi (F)	Sweden	Invited

Comparative high-resolution spectroscopy of M dwarfs: Exploring non-LTE effects	Terese Olander (F)	Sweden	Contributed
Contribution of small telescopes at the Oukaimeden Observatory in Morocco to study Atmospheric dynamics and shocks in variables stars RR Lyr and R sct	Abdelmajid Benhida (M)	Morocco	Contributed

Wednesday, August 9

Wednesday morning		**Country**	**Type**
Atomic data from the UV to the IR	Christian Clear (M)	UK	Invited
Accurate new atomic data needed for Galactic Surveys	Teruca Belmonte (F)	Spain	Invited
Critically Compiled Atomic Data for Singly Ionized Carbon	Haris Kunari (M)	India	Invited
New Laboratory Atomic Data for Neutral, Singly and Doubly Ionised Iron Group Elements for Applications in Astrophysics	Milan Ding (M)	UK	Invited

Wednesday afternoon 1			
Precision X-ray spectroscopy	Randall Smith (M)	USA	Invited
The Fe XVII 3C/3D Oscillator Strength Problem	Sonja Bernitt (F)	Germany	Invited
Modeling X-ray Emission from Charge Exchange Collisions in Astrophysical Spectra	Renata Cumbee (F)	USA	Invited

Wednesday afternoon 2			
Models of hazes in exoplanetary atmospheres	Ella Sciamma-O'Brien (F)	USA	Invited
The Next-Generation Laboratory Experiments on Planetary Materials	Xinting Yu (F)	USA	Invited
Signatures of r-process elements in kilonova spectra	Nanae Domoto (F)	Japan	Contributed
Kilonovae and the cosmic origin of r-process elements: atomic structure and processes of gold	Serna Caliskan (F)	Sweden	Contributed

Thursday, August 11

Thursday morning		**Country**	**Type**
The Synergy Between Laboratory Spectroscopy and Observational Astronomy in the Far-IR	Susanna Widicus Weaver (F)	USA	Invited
Laboratory Challenges for Solar System Science	Stefanie Milam (F)	USA	Invited
Molecular spectroscopy with optical frequency combs	Hiroyuki Sasada (M)	Japan	Invited

Thursday afternoon 1			
Heavy element opacity for multi-messenger observations of neutron star mergers	Masaomi Tanaka (M)	Japan	Invited
Diffuse Interstellar Bands	Michael Gatchel (M)	Sweden	Invited
VUV spectroscopy for photo-processing of astrophysical ices	Asper Chen (M)	Taiwan	Invited

Thursday afternoon 2			
Branching Ratios and Atomic Transition Probabilities of Fe II in the Vacuum Ultraviolet Region	Jacob Ward (M)	USA	Invited
High resolution molecular spectroscopy in the CAS laboratories	Silvia Spezzano (F)	Germany	Invited
Symposium closing	Gillian Nave (F)	USA	Invited

IAUS371: Meeting summary

Quantitative astrophysics depends on spectroscopy, and spectroscopy depends on reliable laboratory data. A person central to that laboratory data in the mid-twentieth century was Charlotte Moore (later Charlotte Moore Sitterly, CMS), probably best known for her compendium "A Multiplet Table of Astrophysical Interest." IAU Symposium 371 was proposed to honor that important contribution, and to examine the current state of quantitative spectroscopy, from the standpoint of both the laboratory and the observatory.

A highlight of the plenary session for the symposium was learning of CMS' life and career, and how she came to do her vital work at Princeton, Mount Wilson, and the US National Bureau of Standards (now NIST). This was accompanied by a synopsis and appreciation of what her work means today and the frontiers it opened.

The need for precise and accurate laboratory data has never been greater. Every time better spectrographs are built or new wavelength domains explored, we find critical information missing that is needed for analyses. As an example, the advent of ALMA forced a need for millimeter-wave laboratory data of a quality to match what was coming from the facility. And improved knowledge of physics leads to challenges in interpreting models of stars and planets. How much UV opacity are we still missing? How can we improve the interpretation of exoplanet observations, both from direct imaging and from transit spectroscopy? Do we truly know the absolute abundances in the Sun of such key elements as carbon, nitrogen, and oxygen? How can we extract the best information from the necessarily low-resolution of celestial objects to compare to high-resolution lab data? All of these areas are in flux.

The subjects included in IAUS 371 include:

- The state of the art in laboratories
- Community needs in coming years
- Abundances and opacities, including:
    - The state of solar analyses
    - Databases of atomic and molecular data
    - The challenges of supernovae and kilonovae
- Complex atmospheres and the search for biomarkers
- Advances in facilities and instruments
    - Laboratory data for high-resolution x-ray spectroscopy
    - Improving wavelength precision and accuracy

IAUS featured 32 speakers: 17 female and 15 male. The speakers came from 11 countries across 4 continents.

IAUS 371: Meeting highlights

When Charlotte Moore Sitterly did her important work, the focus was heavily on data for optical spectra, with the Sun as a primary source of observational motivation. In IAUS 371 we saw how now, in the twenty-first century, the scope of astrophysics has broadened enormously to include sources at all wavelengths from x-rays to radio. For example:

- The search for biomarkers – molecules that can indicate sign of life on an exoplanet – necessarily involves studying the formation and chemistry of complex molecules and at lower temperatures and higher pressures than are traditionally associated with astrophysics. This requires new domains of laboratory efforts that are difficult and challenging, such as understanding the formation and physics of atmospheric hazes.
- CMS' compendium – *A Multiplet Table of Astrophysical Interest* – may be virtually unknown to a new generation of spectroscopists because those data have moved on-line into archives and databases. Their breadth and timeliness add significantly to their quality and utility.
- Seemingly exotic elements with high atomic numbers have become of significance in neutron star mergers that lead to so-called "kilonovae." The opacities of lanthanides are especially relevant to this problem.
- Even within the realm of more-or-less conventional stellar spectroscopy, some area pose special problems. A notable example are the M dwarfs, which can have highly non-homogeneous atmospheres that are rich in molecules. Computational capabilities are now sufficient to address these situations that include non-LTE effects numerically, leading to a fuller understanding of these cool objects that dominate Galactic populations by numbers and which are the sites of current planet-detection programs. The atmospheres of exoplanets around these very-low-mass stars are not so different from their stellar hosts, and so the problems are as complex.
- The best-studied and best-characterized star – the Sun, of course – can still confound us at times. The absolute abundances of the chemical elements that compose the Sun cannot be measured easily, particularly for such critical sources of interior opacity as C, N, and O. This remains an unresolved problem, but direct measurements of CNO opacities under solar-like conditions are now limiting the possibilities and may point to a solution.