EP 3: Astrophysics III

Time: Tuesday 11:00–12:15 Location: KH 01.019

EP 3.1 Tue 11:00 KH 01.019

mw-atlas: Towards the three-dimensional shape of the Milky Way Galaxy in Gas and Dust — •Fabian Polnitzky, Laurin Söding, and Philipp Mertsch — RWTH Aachen University

From our position inside the Milky Way, we have a unique vantage point which obscures the galaxy's overall shape. Despite decades of research, no definite answer has been found regarding its exact structure. In recent years, the focus has shifted towards three-dimensional spatial mapping of the galaxy, in comparison to two-dimensional observations of the sky, leading to the discovery of previously unknown features such as the Radcliffe Wave.

To construct these maps, we require new observational data, but more importantly, new statistical techniques that bridge the transition from two to three dimensions. A promising avenue for this is information field theory, which was successfully used to map the spatial distribution of parts of the Milky Way.

Components, that are mapped in three dimensions now, include neutral hydrogen gas across the entire galaxy and interstellar dust in the local neighbourhood of the sun. In my talk, I will provide an overview of the techniques used to create these maps, summarize our current understanding, and highlight what we know about them. I will also discuss how combining neutral hydrogen gas and interstellar dust can further improve our three-dimensional view of the Milky Way, by leveraging correlations between them.

EP 3.2 Tue 11:15 KH 01.019

mw-atlas: Inferring the Milky Ways gravitational potential from stellar streams — •Matthias Hübl and Philipp Mertsch — RWTH Aachen University

The Milky Ways gravitational potential governs the large scale dynamics and imprints itself on the movement of gas, dust and stars around the Galactic center. Stellar streams, groups of stars that were stripped from a common progenitor cluster, can be seen as tracer particles within this potential that have very similar kinematic properties. Seen as elongated features along the sky, they almost perfectly map out orbits, and with the abundance of high quality astronomical data taken in recent years, it is now feasible to use them to constrain the Milky Ways gravitational potential in unprecedented ways. Using powerful and flexible methods like geometric variational inference, it is possible to infer the potential without fixing its exact shape to a rigid analytical form. This way we are able to constrain the deviation of the gravitational potential from a perfectly spherical one, namely its triaxiality, and thus the shape of the Galaxies dark matter halo within our Bayesian framework.

EP 3.3 Tue 11:30 KH 01.019

An in-depth characterization of fiber-to-chip coupling interfaces in arrayed waveguide spectrographs for astronomy — •Tim Schleifer[1,2], Aashia Rahman[2], Kalaga Madhav[2], Michael Gensch[1,3], and Andreas Stoll[2] — [1]Technische Universität Berlin, Berlin, Germany — [2]Leibniz-Institut für Astrophysik Potsdam, Potsdam, Germany — [3]DLR Institute of Space Research, Berlin, Germany

Astrophotonics offers a pathway toward miniaturized and highly stable astronomical instruments for next-generation telescopes. A chip-based arrayed waveguide grating (AWG) acts as the main dispersive element in an astrophotonic spectrograph, with a key limitation arising at the fiber-to-chip interface, where coupling losses can critically impact overall throughput. Characterizing and optimizing this interface is essential to ensuring efficient light transfer. This work focuses on the development of a warm astrophotonic spectrograph based on an AWG with a 16-fiber input array coupled to the AWG chip. A silica-on-silicon AWG chip with 15 input waveguides and a diced output facet was used. The resulting echellogram was recorded using a C-RED 2, an infrared camera used in astronomy. A detailed characterization of fiber-to-chip coupling that includes theoretical models, simulations, and experimental measurements was done for a single fiber coupled to an input waveguide of the AWG. Subsequently, all 16 input waveguides were individually assessed to evaluate performance variations across the array. Future work includes a characterization of throughput and spectral resolution followed by an on-sky test to demonstrate the feasibility of a multi-fiber astrophotonic spectrograph.

EP 3.4 Tue 11:45 KH 01.019

Langmuir waves in astrophysical Druyvesteyn plasmas — Simon Tischmann[1], Rudi Gaelzer[2], Dustin Lee Schroeder[1], Marian Lazar[3], and •Horst Fichtner[1] — [1]Theoretische Physik IV, Ruhr-Universit\"at Bochum, Germany — [2]Instituto de Fisica, Unicersidade Federal do Rio Grande do Sul, Brazil — [3]Centre for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Belgium

We present a new model for linear dispersion studies in astrophysical plasmas, by introducing astrophysical Druyvesteyn plasmas. This model can reproduce not only high-energy tails, as observed in situ in the solar wind, but also low-energy flat-tops of the velocity distributions, like those of electrons in interplanetary shocks. The dispersion relation of longitudinal waves is derived in terms of the newly introduced Druyvesteyn dispersion function. The dispersion curves as well as damping rates of high-frequency Langmuir waves are numerically computed for the isotropic case using the ALPS code, and their analytical approximations are provided in the limit of weak damping. This way we offer a new tool for modeling longitudinal waves, and in particular Langmuir waves, that may be useful for other astrophysical systems which are in non-equilibrium states as evidenced by direct insitu measurements, like the solar corona and planetary environments, as well as by indirect observations of nonthermal sources of waves and emissions.

EP 3.5 Tue 12:00 KH 01.019

Adequate Coordinate System for Space Navigation — •Hans-Otto Carmesin — Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen — Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade

The International Astronomical Union (IAU) realized, that the coordinate systems of relativity theory are insufficient for space navigation. Therefore, the IAU proclaimed the problem of finding an adequate coordinate system (ACS).

Here, that problem is solved:

(1) A measurement procedure is presented.

(2) For each Point P, an ACS and its velocity $\vec{v}_{ACS,\underline{CS}}$ relative to an arbitrary coordinate system (CS) are deduced.

(3) The ACS is confirmed by an observation at Earth and at space.

(4) The universal zero of the fractional kinematic time difference $\delta t_{kin,fractional}$ is derived.

(5) For each Point P, the fractional kinematic time difference $\delta t_{kin,fractional}$ is derived and predicted.

Carmesin, H.-O. (2025): On the Dynamics of Time, Space and Quanta. Berlin: Verlag Dr. Köster.

Carmesin, H.-O. (2025): Construction of a Physically Adequate Coordinate System with Help of an Observation on Earth's Ground. J Geosci Earth Planet Syst, 1(1), pp. 01-12.