Accelerating changes in ice mass within Greenland, and the ice sheet's sensitivity to atmospheric forcing

From early 2003 to mid-2013, the total mass of ice in Greenland declined at a progressively increasing rate. In mid-2013, an abrupt reversal occurred, and very little net ice loss occurred in the next 12-18 months. Gravity Recovery and Climate Experiment (GRACE) and global positioning system (GPS) observations reveal that the spatial patterns of the sustained acceleration and the abrupt deceleration in mass loss are similar. The strongest accelerations tracked the phase of the North Atlantic Oscillation (NAO). The negative phase of the NAO enhances summertime warming and insolation while reducing snowfall, especially in west Greenland, driving surface mass balance (SMB) more negative, as illustrated using the regional climate model MAR. The spatial pattern of accelerating mass changes reflects the geography of NAO-driven shifts in atmospheric forcing and the ice sheet's sensitivity to that forcing. We infer that southwest Greenland will become a major future contributor to sea level rise.

Analysis of the GRAV-D airborne gravity data for geoid modelling

In this study, airborne gravity data from the Gravity for the Redefinition of the American Vertical Datum (GRAV-D) project are compared with terrestrial gravity data in three survey blocks that cross the Canada-US border. One block (AN04) overlaps an area containing Alaska (USA) and the Yukon Territory (Canada) over a rough terrain while the other two blocks (EN05 and EN08) are within the Great Lakes-St-Lawrence River region with flat and moderate terrains. GRAV-D has an average flight altitude of about 6 km in the three blocks, in which each survey/cross line spans 240–700 km. The high flight altitude of GRAV-D puts forth a challenge for the comparisons. We have developed procedures to interpolate and continue the airborne and terrestrial gravity data to a mean flight height for each block. The remove-compute-restore Poisson method is used in the upward continuation of the terrestrial gravity data by removing and restoring the satellite-only geopotential model GOCO05S. The comparison between the datasets is done using Helmert gravity disturbances in order to satisfy the harmonic condition of the upward continuation. The comparisons show that differences between GRAV-D and terrestrial gravity data are 3.6 mGal for AN04, 1.8 mGal for EN05 and 2.3 mGal for EN08 in terms of Root Mean Square (RMS) at the mean flight height. The results can be improved for two blocks when applying a cross-over adjustment. The differences become 1.0 and 1.4 for EN05 and EN08, respectively.
An attempt to observe vertical land motion along the norwegian coast by CryoSat-2 and tide gauges

Present-day climate-change-related ice-melting induces elastic glacial isostatic adjustment (GIA) effects, while paleo-GIA effects describe the ongoing viscous response to the melting of late-Pleistocene ice sheets. The unloading initiated an uplift of the crust close to the centers of former ice sheets. Today, vertical land motion (VLM) rates in Fennoscandia reach values up to around 10 mm/year and are dominated by GIA. Uplift signals from GIA can be computed by solving the sea-level equation (SLE), \( S' = N' - U' \). All three quantities can also be determined from geodetic observations: relative sea-level variations (\( S' \)) are observed by means of tide gauges, while rates of absolute sea-level change (\( N' \)) can be observed by satellite altimetry; rates of VLM (\( U' \)) can be determined by GPS (Global Positioning System). Based on the SLE, \( U' \) can be derived by combining sea-surface measurements from satellite altimetry and relative sea-level records from tide gauges. In the present study, we have combined 7.5 years of CryoSat-2 satellite altimetry and tide-gauge data to estimate linear VLM rates at 20 tide gauges along the Norwegian coast. Thereby, we made use of monthly averaged tide-gauge data from PSMSL (Permanent Service for Mean Sea Level) and a high-frequency tide-gauge data set with 10-min sampling rate from NMA (Norwegian Mapping Authority). To validate our VLM estimates, we have compared them with the independent semi-empirical land-uplift model NKG2016LU_abs for the Nordic-Baltic region, which is based on GPS, levelling, and geodynamical modeling. Estimated VLM rates from 1 Hz CryoSat-2 and high-frequency tide-gauge data reflect well the amplitude of coastal VLM as provided by NKG2016LU_abs. We find a coastal average of 2.4 mm/year (average over all tide gauges), while NKG2016LU_abs suggests 2.8 mm/year; the spatial correlation is 0.58.

Broad Absorption Line Disappearance/Emergence in Multiple Ions in a Weak Emission-line Quasar

We report the discovery of the disappearance of Mg ii, Al iii, C iv, and Si iv broad absorption lines (BALs) at the same velocity (0.07c), accompanied by a new C iv BAL emerging at a higher velocity (up to 0.11c), in the quasar J0827+4252 at z = 2.038. This is the first report of BAL disappearance (i) over Mg ii, Al iii, C iv, and Si iv ions and (ii) in a weak emission-
line quasar (WLQ). The discovery is based on four spectra from the Sloan Digital Sky Survey and one follow-up spectrum from Hobby-Eberly Telescope/Low-Resolution Spectrograph-2. The simultaneous C iv BAL disappearance and emergence at different velocities, together with no variations in the Catalina Real-Time Transient Survey light curve, indicate that ionization changes in the absorbing material are unlikely to cause the observed BAL variability. Our analyses reveal that transverse motion is the most likely dominant driver of the BAL disappearance/emergence. Given the presence of mildly relativistic BAL outflows and an apparently large C iv emission-line blueshift that is likely associated with strong bulk outflows in this WLQ, J0827+4252 provides a notable opportunity to study extreme quasar winds and their potential in expelling material from inner to large-scale regions.

Characterization of the in-flight properties of the Planck telescope

The European Space Agency's Planck satellite was launched on 14 May 2009, and surveyed the sky stably and continuously between August 2009 and October 2013. The scientific analysis of the Planck data requires understanding the optical response of its detectors, which originates partly from a physical model of the optical system. In this paper, we use in-flight measurements of planets within similar to 1 degrees of boresight to estimate the geometrical properties of the telescope and focal plane. First, we use observed grating lobes to measure the amplitude of mechanical dimpling of the reflectors, which is caused by the hexagonal honeycomb structure of the carbon fibre reflectors. We find that the dimpling amplitude on the two reflectors is larger than expected from the ground, by 20% on the secondary and at least a factor of 2 on the primary. Second, we use the main beam shapes of 26 detectors to investigate the alignment of the various elements of the optical system, as well as the large-scale deformations of the reflectors. We develop a metric to guide an iterative fitting scheme, and are able to determine a new geometric model that fits the in-flight measurements better than the pre-flight prediction according to this metric. The new alignment model is within the mechanical tolerances expected from the ground, with some specific but minor exceptions. We find that the reflectors contain large-scale sinusoidal deformations most probably related to the mechanical supports. In spite of the better overall fit, the new model still does not fit the beam measurements at a level compatible with the needs of cosmological analysis. Nonetheless, future analysis of the Planck data would benefit from taking into account some of the features of the new model. The analysis described here exemplifies some of the limitations of in-flight retrieval of the geometry of an optical system similar to that of Planck, and provides useful information for similar efforts in future experiments.
Cold gas in the early Universe - Survey for neutral atomic-carbon in GRB host galaxies at 1 < z< 6 from optical afterglow spectroscopy

We present a survey for neutral atomic-carbon (CI) along gamma-ray burst (GRB) sightlines, which probes the shielded neutral gas-phase in the interstellar medium (ISM) of GRB host galaxies at high redshift. We compile a sample of 29 medium- to high-resolution GRB optical afterglow spectra spanning a redshift range through most of cosmic time from 1 < z < 6. We find that seven (≈25%) of the GRBs entering our statistical sample have CI detected in absorption. It is evident that there is a strong excess of cold gas in GRB hosts compared to absorbers in quasar sightlines. We investigate the dust properties of the GRB CI absorbers and find that the amount of neutral carbon is positively correlated with the visual extinction, AV, and the strength of the 2175 Å dust extinction feature, Abump. GRBs with CI detected in absorption are all observed above a certain threshold of logN(HI)/cm$^{-2}$ + [X/H] > 20.7 and a dust-phase iron column density of logN(Fe)$_{dust}$/cm$^{-2}$ > 16.2. In contrast to the SED-derived dust properties, the strength of the CI absorption does not correlate with the depletion-derived dust properties. This indicates that the GRB CI absorbers trace dusty systems where the dust composition is dominated by carbon-rich dust grains. The observed higher metal and dust column densities of the GRB CI absorbers compared to H2- and CI-bearing quasar absorbers is mainly a consequence of how the two absorber populations are selected, but is also required in the presence of intense UV radiation fields in actively star-forming galaxies.

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Deciphering an evolutionary sequence of merger stages in infrared-luminous starburst galaxies at z ∼ 0.7

Based on optical and near-IR Magellan FIRE spectra of 25 starburst galaxies at 0.5 < z< 0.9, a recent publication showed that their attenuation properties can be explained by a single-parameter sequence of total obscurations ranging from A_V = 2 to A_V = 30 toward the starburst core centers in a mixed stars and dust configuration. We investigate here the origin of this sequence for the same sample. We show that total attenuations anticorrelate with the starburst sizes in radio (3 GHz) with a significance larger than 5σ and a scatter of 0.26 dex. More obscured and compact starbursts also show enhanced N2 (=[NII]/Hα) ratios and larger line velocity widths that we attribute to an increasing shock contribution toward later merger phases, driven by deeper gravitational potential wells at the coalescence. Additionally, the attenuation is also linked to the equivalent width (EW) of hydrogen recombination lines, which is sensitive to the luminosity weighted age of the relatively unobscured stellar populations. Overall, the correlations among A_V, radio size, line width, N2 and EW of Balmer and Paschen lines converge toward suggesting an evolutionary sequence of merger stages: all of these quantities are likely to be good time-tracers of the merger phenomenon, and their large spanned range appears to be characteristic of the different merger phases. Half of our sample at higher obscurations have radio sizes approximately 3 times smaller than early type galaxies at the same redshift, suggesting that, in analogy with local ultraluminous infrared galaxies (ULIRGs), these cores cannot be directly forming elliptical galaxies. Finally, we detect mid-IR AGN torus for half of our sample and additional X-ray emission for 6 starbursts; intriguingly, the latter have systematically more compact sizes, suggestive of emerging AGNs toward later merger stages, possibly precursors of a later QSO phase.

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Dense matter with eXTP
In this White Paper we present the potential of the Enhanced X-ray Timing and Polarimetry (eXTP) mission for determining the nature of dense matter; neutron star cores host an extreme density regime which cannot be replicated in a terrestrial laboratory. The tightest statistical constraints on the dense matter equation of state will come from pulse profile modelling of accretion-powered pulsars, burst oscillation sources, and rotation-powered pulsars. Additional constraints will
derive from spin measurements, burst spectra, and properties of the accretion flows in the vicinity of the neutron star.

Under development by an international Consortium led by the Institute of High Energy Physics of the Chinese Academy of Sciences, the eXTP mission is expected to be launched in the mid 2020s.

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**Evaluation of a Compton camera concept using the 3D CdZnTe drift strip detectors**

At DTU Space, a high-resolution 3D CZT drift strip detector has been developed and a number of prototype detectors were fabricated, allowing for sub-mm position resolution at high energies (> 100 keV), as well as high energy resolution. For spectral and spatial performance, the 3D CZT prototype detectors were characterized with a fine collimated high-energy (Cs137) monochromatic beam (0.2 mm x 40 mm) using a digitizer with which the pulse shapes of the bipolar signals from all electrodes could be analysed. Data analysis consist of position determination for single as well as double interaction events handled within the detector. The double interaction events (e.g. Compton interaction) are utilized to characterize the imaging performance of the 3D CZT drift strip detector prototype when operating as a Compton camera.

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Firm data compilation reveals widespread decrease of firm air content in western Greenland

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Contributors: Vandecrux, B. R. M., MacFerrin, M., Machguth, H., Colgan, W. T., van As, D., Heilig, A., Stevens, C. M., Charalampidis, C., Fausto, R. S., Morris, E. M., Mosley-Thompson, E., Koenig, L., Montgomery, L. N., Miège, C., Simonsen, S. B., Ingeman-Nielsen, T., Box, J. E.
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Geodetic and model data reveal different spatio-temporal patterns of transient mass changes over Greenland from 2007 to 2017

Much of the research to understand the ice mass changes of Greenland ice sheet (GrIS) has focused on detecting linear rates and accelerations at decadal or longer periods. The transient (short-term, non-secular) mass changes show large variability, and if not properly accounted for, can introduce significant biases into estimates of long-term ice mass loss rates and accelerations. Despite the growing number of geodetic observations, in terms of spatial coverage, types of observables, and the extent of the time series, studies of the transient mass changes over GrIS are lacking. To address this limitation, we apply multi-channel singular spectral analysis to the Gravity Recovery and Climate Experiment (GRACE) mass concentrations (mascon), surface mass balance (SMB) model output, and ice discharge data, to determine the transient mass changes over Greenland over the decade (2007 to 2017). The goal of this analysis is to elucidate the spatio-temporal variability of the ice mass change. For the entire GrIS, both the mascon and SMB transient mass changes are characterized by a sustained mass gain from late 2007 to early 2010, a sustained mass loss from early 2010 to early 2013, and a mass gain from early 2013 to mid-2015. Global Positioning System sites deployed along the coast of Greenland showed uplift from early 2010 to early 2013 and subsidence from early 2013 to 2015, consistent with the
corresponding ice mass loss and gain of the entire GrIS. The peak-to-peak amplitude of the transient mass change was estimated to be \(-294 \pm 27\) Gt from GRACE mascons and \(-252 \pm 16\) Gt from the SMB where the latter value includes the effect of ice discharge. The transient mass change due to ice discharge accounted for less than 10% of the total transient mass change. Our regional assessment reveals that the central-west, southwest, northeast, and southeast regions display similar time-varying patterns as we found for the entire GrIS, but the north and northwest regions show different patterns. Atmospheric circulation anomalies as measured by the Greenland Blocking Index (GBI) are able to explain most of these transient anomalies. More specifically, high-GBI-associated high temperature was one of the main reasons for the transient mass loss of the entire GrIS during 2010-2012 while low GBI can explain the transient mass gain during 2013-2015. Contrasting behaviors of precipitation anomalies in east and west Greenland under abnormally high or low GBI conditions may explain the different patterns of the transient mass change in the northwest and the rest of Greenland.

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Gold–carbonyl group interactions in the electrochemistry of anthraquinone thiols self-assembled on Au(111)-surfaces
New anthraquinone derivatives with either a single or two thiol groups (AQ1 and AQ2) were synthesized and immobilized in self-assembled monolayers (SAMs) on Au(111) electrodes via Au–S bonds. The resultant AQ1- and AQ2-SAMs were studied by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS), which enabled mapping of the gold–carbonyl group interactions and other dynamics in the Au–S bound molecular framework. Understanding of these interactions is important for research on thiol-coated gold nanoclusters, since (I) anthraquinone derivatives are a major compound family for providing desired redox functionality in multifarious assays or devices, and (II) the gold–carbonyl interactions can strongly affect anthraquinone electrochemistry. Based on equivalent circuit analysis, it was found that there is a significant rise in polarization resistance (related to SAM structural reorganization) at potentials that can be attributed to the quinone/semi-quinone interconversion. The equivalent circuit model was validated by calculation of pseudocapacitance for quinone-to-hydroquinone interconversion, in good agreement with the values derived from CV. The EIS and CV patterns obtained provide consistent evidence for two different ECEC (i.e., proton-controlled ET steps, PCET) pathways in AQ1- and AQ2-SAMs. Notably, it was found that the formal reorganization (free) energies obtained for the elementary PCET steps are unexpectedly small for both SAMs studied. This anomaly suggests high layer rigidity and recumbent molecular orientation on gold surfaces, especially for the AQ2-SAMs. The results strongly indicate that gold–carbonyl group interactions can be controlled by favorable structural organization of anthraquinone-based molecules on gold surfaces.

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HARPS-N radial velocities confirm the low densities of the Kepler-9 planets

We investigated the discrepancy between planetary mass determination using the transit timing variations (TTVs) and radial velocities (RVs), by analysing the multi-planet system Kepler-9. Despite being the first system characterised with TTVs, there are several discrepant solutions in the literature, with those reporting lower planetary densities being apparently in disagreement with high-precision RV observations. To resolve this, we gathered HARPS-N RVs at epochs that maximised the difference between the predicted RV curves from discrepant solutions in the literature. We also re-analysed the full Kepler data-set and performed a dynamical fit, within a Bayesian framework, using the newly derived central and duration times of the transits. We compared these results with the RV data and found that our solution better describes the RV observations, despite the masses of the planets being nearly half that presented in the discovery paper. We therefore confirm that the TTV method can provide mass determinations that agree with those determined using high-precision RVs. The low densities of the planets place them in the scarcely populated region of the super-Neptunes / inflated sub-Saturns in the mass-radius diagram.

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**HD 202772A b: A Transiting Hot Jupiter around a Bright, Mildly Evolved Star in a Visual Binary Discovered by TESS**

We report the first confirmation of a hot Jupiter discovered by the Transiting Exoplanet Survey Satellite (TESS) mission: HD 202772A b. The transit signal was detected in the data from TESS Sector 1, and was confirmed to be of planetary origin through radial velocity (RV) measurements. HD 202772A b is orbiting a mildly evolved star with a period of 3.3 days. With an apparent magnitude of V = 8.3, the star is among the brightest and most massive known to host a hot Jupiter. Based on the 27 days of TESS photometry and RV data from the CHIRON, HARPS, and Tillinghast Reflector Echelle Spectrograph, the planet has a mass of $1.017^{+0.070}_{-0.068} M_J$ and radius of $1.545^{+0.052}_{-0.060} R_J$, making it an inflated gas giant. HD 202772A b is a rare example of a transiting hot Jupiter around a quickly evolving star. It is also one of the most strongly irradiated hot Jupiters currently known.

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**Hidden or missing outflows in highly obscured galaxy nuclei?**

**Context.** Understanding the nuclear growth and feedback processes in galaxies requires investigating their often obscured central regions. One way to do this is to use (sub)millimeter line emission from vibrationally excited HCN (HCN-vib), which is thought to trace warm and highly enshrouded galaxy nuclei. It has been suggested that the most intense HCN-vib emission from a galaxy is connected to a phase of nuclear growth that occurs before the nuclear feedback processes have been fully developed.

**Aims.** We aim to investigate if there is a connection between the presence of strong HCN-vib emission and the development of feedback in (ultra)luminous infrared galaxies ((U)LIRGs).

**Methods.** We collected literature and archival data to compare the luminosities of rotational lines of HCN-vib, normalized to the total infrared luminosity, to the median velocities of 119 μm OH absorption lines, potentially indicating outflows, in a total of 17 (U)LIRGs.

**Results.** The most HCN-vib luminous systems all lack signatures of significant molecular outflows in the far-infrared OH absorption lines. However, at least some of the systems with bright HCN-vib emission have fast and collimated outflows that can be seen in spectral lines at longer wavelengths, including in millimeter emission lines of CO and HCN (in its vibrational ground state) and in radio absorption lines of OH.

**Conclusions.** We conclude that the galaxy nuclei with the highest $L_{HCN-vib}/L_{IR}$ do not drive wide-angle outflows that are detectable using the median velocities of far-infrared OH absorption lines. This is possibly because of an orientation effect in which sources oriented in such a way that their outflows are not along our line of sight also radiate a smaller proportion of their infrared luminosity in our direction. It could also be that massive wide-angle outflows destroy the deeply embedded regions responsible for bright HCN-vib emission, so that the two phenomena cannot coexist. This would strengthen the idea that vibrationally excited HCN traces a heavily obscured stage of evolution before nuclear feedback mechanisms are
Ice dynamics of union glacier from SAR offset tracking
The Antarctic ice sheet is predicted to be the major contributor to sea-level rise during the XXI century. Therefore, monitoring ice dynamics of outlet glaciers in Antarctica is of great importance to assess future sea-level rise predictions. Union Glacier is one of the major outlet glaciers of the Ellsworth Mountains and drains into the Ronne-Filchner Ice Shelf. Glaciers can be studied using remote-sensing techniques, which combined with field measurements can deliver a good approximation of its dynamics and can be used as input for glacier models. In this study we acquired high resolution Stripmap HIMAGE SAR images from the COSMO-SkyMed satellite constellation during austral summer of 2011–2012, and applied a SAR offset tracking algorithm to compute ice velocities. Then, we compared our derived velocities with field data already published. Results showed mean values of ice velocity estimated for the main trunk of the glacier are 0.043 (0.0393 SD) m d−1, with values reaching up to 0.325 m d−1, in agreement with previous studies. A model of ice thickness based on lamellar flow theory is proposed, using estimated surface ice velocity in combination with surface slope derived from TanDEM-X as input data. Comparison of our modeled ice thickness with radar data agree with a mean absolute deviation of 19.22%. From surface ice velocities we computed principal strain rates in order to assess crevasse formation and closure. Thereafter, using high resolution COSMO-SkyMed Spotlight-2 SAR images we establish a relation between surface features and acting strain components.
Chandra-HETGS Characterization of an Outflowing Wind in the Accreting Millisecond Pulsar IGR J17591–2342

An accreting millisecond X-ray pulsar, IGR J17591–2342 was discovered in 2018 August in scans of the Galactic bulge and center by the International Gamma-Ray Astrophysics Laboratory X-ray and gamma-ray observatory. It exhibited an unusual outburst profile with multiple peaks in the X-ray, as observed by several X-ray satellites over 3 months. Here we present observations of this source performed in the X-ray/gamma-ray and near-infrared domains and focus on a simultaneous observation performed with the Chandra High Energy Transmission Gratings Spectrometer (HETGS) and the Neutron Star Interior Composition Explorer (NICER). The HETGS provides high-resolution spectra of the Si edge region that yield clues as to the source’s distance and reveal evidence (at 99.999% significance) of an outflow with a velocity of 2800 km s$^{-1}$. We demonstrate good agreement between the NICER and HETGS continua, provided that one properly accounts for the differing manners in which these instruments view the dust-scattering halo in the source’s foreground. Unusually, we find a possible set of Ca lines in the HETGS spectra (with significances ranging from 97.0% to 99.7%). We hypothesize that IGR J17591–2342 is a neutron star low-mass X-ray binary at the distance of the Galactic bulge or beyond that may have formed from the collapse of a white dwarf system in a rare, calcium-rich Type Ib supernova explosion.

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HSTF160W Imaging of Very Massive Galaxies at 1.5 < z < 3.0: Diversity of Structures and the Effect of Close Pairs on Number Density Estimates

We present a targeted follow-up Hubble Space Telescope WFC3 F160W imaging study of very massive galaxies (log$M_{\text{star}}^{10^9}$) $>$ 11.25 selected from a combination of ground-based near-infrared galaxy surveys (UltraVISTA, NEWFIRM Medium Band Survey-II, UKIRT Infrared Deep Sky Survey (UKIDSS) Ultra-Deep Survey (UDS) at 1.5 < z < 3). We find that these galaxies are diverse in their structures, with ~1/3 of the targets being composed of close pairs, and span a wide range in sizes. At 1.5 < z < 2.5, the sizes of both star-forming and quiescent galaxies are consistent with the extrapolation of the stellar mass–size relations determined at lower stellar masses. At 2.5 < z < 3.0, however, we find evidence that quiescent galaxies are systematically larger than expected based on the extrapolation of the relation derived using lower stellar mass galaxies. We used the observed light profiles of the blended systems to decompose their stellar masses and investigate the effect of the close pairs on the measured number densities of very massive galaxies in the early universe. We estimate correction factors to account for close-pair blends and apply them to the observed stellar mass functions (SMFs) measured using ground-based surveys. Given the large uncertainties associated with this extreme population of galaxies, there is currently little tension between the (blending-corrected) number density estimates and predictions from
theoretical models. Although we currently lack the statistics to robustly correct for close-pair blends, we show that this is a systematic effect that can reduce the observed number density of very massive galaxies by up to a factor of ~1.5, and should be accounted for in future studies of SMFs.

**General information**

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**Improved search for solar chameleons with a GridPix detector at CAST**

We report on a new search for solar chameleons with the CERN Axion Solar Telescope (CAST). A GridPix detector was used to search for soft X-ray photons in the energy range from 200 eV to 10 keV from converted solar chameleons. No significant excess over the expected background has been observed in the data taken in 2014 and 2015. We set an improved limit on the chameleon photon coupling, $\beta \gamma \lesssim 5.7 \times 10^{10}$ for $1 < \beta m < 10^6$ at 95% C.L. improving our previous results by a factor two and for the first time reaching sensitivity below the solar luminosity bound for tachocline magnetic fields up to 12.5 T.

**General information**

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Influence of local geoid variation on water surface elevation estimates derived from multi-mission altimetry for Lake Namco

Water surface elevation (WSE) is an essential quantity for water resource monitoring and hydrodynamic modeling. Satellite altimetry has provided data for inland water bodies. The height that is derived from altimetry measurement is ellipsoidal height. In order to convert the ellipsoidal height to orthometric height, which has physical meaning, accurate estimates of the geoid are needed. This paper evaluates the suitability of geodetic altimetric measurements for improvement of global geoid models over a large lake in the Tibetan Plateau. CryoSat-2 and SARAL/AltKa are used to derive the high-frequency geoid correction. A validation of the local geoid correction is performed with data from in-situ observations, a laser altimetry satellite (ICESat), a Ka-band radar altimetry satellite (SARAL) and a SAR radar altimetry satellite (Sentinel-3). Results indicate that the geodetic altimetric dataset can capture the high-resolution geoid information. By applying local geoid correction, the precision of ICESat, SARAL and Sentinel-3 retrievals are significantly improved. We conclude that using geodetic altimetry to correct for local geoid residual over large lakes significantly decreases the uncertainty of WSE estimates. These results also indicate the potential of geodetic altimetry missions to determine local geoid residual with centimeter-level accuracy, which can be used to improve global and regional geopotential models.

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Innovative Multi-Feed-Per-Beam Reflector Antenna for Space-Borne Conical-Scan Radiometers
We present an antenna for use on conical-scan space-borne radiometers in C band and demonstrate that stringent radiometric requirements can be met. The antenna consists of as m offset reflector fed by a focal plane array in a multi-feed-per-beam configuration, so far never used in ocean observation missions. We use distinct element beams and two optimization routines for obtaining element excitation amplitudes and phases, and with either routine, and in both x- and y-polarization, compliant beams, with footprint < 20 km, distance to coast < 20 km and accuracy < 0.25 K, are obtained. These results may pave the way for use of focal plane arrays with digital beamforming in future radiometric ocean
In situ observed relationships between snow and ice surface skin temperatures and 2 m air temperatures in the Arctic

To facilitate the construction of a satellite-derived 2 m air temperature ($T_{2m}$) product for the snow- and ice-covered regions in the Arctic, observations from weather stations are used to quantify the relationship between the $T_{2m}$ and skin temperature ($T_{skin}$). Multiyear data records of simultaneous $T_{skin}$ and $T_{2m}$ from 29 different in situ sites have been analysed for five regions, covering the lower and upper ablation zone and the accumulation zone of the Greenland Ice Sheet (GrIS), sea ice in the Arctic Ocean, and seasonal snow-covered land in northern Alaska. The diurnal and seasonal temperature variabilities and the impacts from clouds and wind on the $T_{2m}$–$T_{skin}$ differences are quantified. $T_{skin}$ is often (85 % of the time, all sites weighted equally) lower than $T_{2m}$, with the largest differences occurring when the temperatures are well below 0 °C or when the surface is melting. Considering all regions, $T_{2m}$ is on average 0.65–2.65 °C higher than $T_{skin}$, with the largest differences for the lower ablation area and smallest differences for the seasonal snow-covered sites. A negative net surface radiation balance generally cools the surface with respect to the atmosphere, resulting in a surface-driven surface air temperature inversion. However, $T_{skin}$ and $T_{2m}$ are often highly correlated, and the two temperatures can be almost identical (<0.5 °C difference), with the smallest $T_{2m}$–$T_{skin}$ differences occurring around noon and early afternoon during spring, autumn and summer during non-melting conditions. In general, the inversion strength increases with decreasing wind speeds, but for the sites on the GrIS the maximum inversion occurs at wind speeds of about 5 m s$^{-1}$ due to the katabatic winds. Clouds tend to reduce the vertical temperature gradient, by warming the surface, resulting in a mean overcast $T_{2m}$–$T_{skin}$ difference ranging from ~0.08 to 1.63 °C, with the largest differences for the sites in the snow-covered zone and the smallest differences for the seasonal snow-covered sites. To assess the effect of using cloud-limited infrared satellite observations, the influence of clouds on temporally averaged $T_{skin}$ has been studied by comparing averaged clear-sky $T_{skin}$ with averaged all-sky $T_{skin}$. To this end, we tested three different temporal averaging windows: 24 h, 72 h and 1 month. The largest clear-sky biases are generally found when 1-month averages are used and the smallest clear-sky biases are found for 24 h. In most cases, all-sky averages are warmer than clear-sky averages, with the smallest bias occurring during summer when the $T_{skin}$ range is smallest.

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BFI (2019): BFI-level 1
K2-140b and K2-180b – Characterization of a hot Jupiter and a mini-Neptune from the K2 mission

We report the independent discovery and characterization of two K2 planets: K2-180b, a mini-Neptune-sized planet in an 8.9-d orbit transiting a V = 12.6 mag, metal-poor ([Fe/H] = −0.65 ± 0.10) K2V star in K2 campaign 5; K2-140b, a transiting hot Jupiter in a 6.6-d orbit around a V = 12.6 mag G6V ([Fe/H] = +0.10 ± 0.10) star in K2 campaign 10. Our results are based on K2 time-series photometry combined with high-spatial resolution imaging and high-precision radial velocity measurements. We present the first mass measurement of K2-180b. K2-180b has a mass of \( M_p = 11.3 \pm 1.9 M_{\oplus} \) and a radius of \( R_p = 2.2 \pm 0.1 R_{\oplus} \), yielding a mean density of \( \rho_p = 5.6 \pm 1.9 g/cm^3 \), suggesting a rocky composition. Given its radius, K2-180b is above the region of the so-called ‘planetary radius gap’. K2-180b is in addition not only one of the densest mini-Neptune-sized planets, but also one of the few mini-Neptune-sized planets known to transit a metal-poor star. We also constrain the planetary and orbital parameters of K2-140b and show that, given the currently available Doppler measurements, the eccentricity is consistent with zero, contrary to the results of a previous study.

Masses and radii for the three super-Earths orbiting GJ 9827, and implications for the composition of small exoplanets

Super-Earths belong to a class of planet not found in the Solar System, but which appear common in the Galaxy. Given that some super-Earths are rocky, while others retain substantial atmospheres, their study can provide clues as to the formation of both rocky planets and gaseous planets, and - in particular - they can help to constrain the role of photo-evaporation in sculpting the exoplanet population. GJ 9827 is a system already known to host 3 super-Earths with orbital
periods of 1.2, 3.6 and 6.2 days. Here we use new HARPS-N radial velocity measurements, together with previously
published radial velocities, to better constrain the properties of the GJ 9827 planets. Our analysis can’t place a strong
constraint on the mass of GJ 9827 c, but does indicate that GJ 9827 b is rocky with a composition that is probably similar
to that of the Earth, while GJ 9827 d almost certainly retains a volatile envelope. Therefore, GJ 9827 hosts planets on
either side of the radius gap that appears to divide super-Earths into pre-dominantly rocky ones that have radii below
∼1.5R⊕, and ones that still retain a substantial atmosphere and/or volatile components, and have radii above ∼2R⊕. That
the less heavily irradiated of the 3 planets still retains an atmosphere, may indicate that photoevaporation has played a
key role in the evolution of the planets in this system.

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Organisations: Astrophysics and Atmospheric Physics, National Space Institute, University of California at Berkeley,
University of Edinburgh, National Institute for Astrophysics, University of Cambridge, University of Texas at Austin,
Harvard-Smithsonian Center for Astrophysics, Harvard University, University of St Andrews, Queen's University Belfast,
Université de Genève, Fundación Galileo Galilei, Universita di Padova, European Southern Observatory, NASA Goddard
Space Flight Center
Poretti, E., Zeng, L., Cameron, A. C., Damasso, M., Coffinet, A., Latham, D. W., Bonomo, A. S., Bouchy, F.,
Mayor, M., Micela, G., Molinari, E., Nascimbeni, V., Nava, C., Pepe, F., Phillips, D. F., Piotto, G., Sasselov, D.,
Ségransan, D., Sozzetti, A., Udry, S., Watson, C.
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Measuring Coseismic Deformation With Spaceborne Synthetic Aperture Radar: A Review
In the past 25 years, space-borne Synthetic Aperture Radar imagery has become an increasingly available data source for
the study of crustal deformation associated with moderate to large earthquakes (M > 4.0). Coseismic surface deformation
can be measured with several well-established techniques, the applicability of which depends on the ground displacement
pattern, on several radar parameters, and on the surface properties at the time of the radar acquisitions. The state-of-the-
art concerning the measurement techniques is reviewed, and their application to over 100 case-studies since the launch of
the Sentinel-1a satellite is discussed, including the performance of the different methods and the data processing aspects,
which still constitute topics of ongoing research.

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Organisations: National Space Institute
Corresponding author: Peter Merryman Boncori, J.
Contributors: Peter Merryman Boncori, J.
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Molecular and Ionized Gas Phases of an AGN-driven Outflow in a Typical Massive Galaxy at z = 2

Nuclear outflows driven by accreting massive black holes are one of the main feedback mechanisms invoked at high-z to reproduce the distinct separation between star-forming disk galaxies and quiescent spheroidal systems. Yet our knowledge of feedback at high-z remains limited by the lack of observations of the multiple gas phases in galaxy outflows. In this work, we use new deep, high spatial resolution ALMA CO(3-2) and archival Very Large Telescope/SINFONI Hα observations to study the molecular and ionized components of the active galactic nucleus (AGN)-driven outflow in zC400528, a massive main-sequence galaxy at z = 2.3 in the process of quenching. We detect a powerful molecular outflow that shows a positive velocity gradient before a turnover and extends for at least similar to 10 kpc from the nuclear region, about three times the projected size of the ionized wind. The molecular gas in the outflow does not reach velocities high enough to escape the galaxy and is therefore expected to be reaccreted. Keeping in mind the various assumptions involved in the analysis, we find that the mass and energetics of the outflow are dominated by the molecular phase. The AGN-driven outflow in zC400528 is powerful enough to deplete the molecular gas reservoir on a timescale comparable to that needed to exhaust it by star formation. This suggests that the nuclear outflow is one of the main quenching engines at work in the observed suppression of the central star formation activity in zC400528.
Observatory science with eXTP

In this White Paper we present the potential of the enhanced X-ray Timing and Polarimetry (eXTP) mission for studies related to Observatory Science targets. These include flaring stars, supernova remnants, accreting white dwarfs, low and high mass X-ray binaries, radio quiet and radio loud active galactic nuclei, tidal disruption events, and gamma-ray bursts. eXTP will be excellently suited to study one common aspect of these objects: their often transient nature. Developed by an international Consortium led by the Institute of High Energy Physics of the Chinese Academy of Science, the eXTP mission is expected to be launched in the mid 2020s.

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Optical constants of magnetron sputtered Pt thin films with improved accuracy in the N- and O-electronic shell absorption regions

We present an experimental, self-consistent determination of the optical constants (refractive index) of Pt using a combination of photoabsorption and reflectance data in the photon energy range 25–778 eV, which includes the N- and O-shell electronic absorption edges of Pt. We compare our new experimental values with Pt optical constant data sets from the literature. Our Pt optical constant values reveal highly resolved absorption-edge fine structure around the O2,3 and N6,7 edges in both the absorptive and dispersive portions of the refractive index, which were missing in the earlier literature.

General information
Publication status: Published
Organisations: Astrophysics and Atmospheric Physics, National Space Institute, Lawrence Livermore National Laboratory, University Paris-Saclay, Lawrence Berkeley National Laboratory
Oscillations in the Sun with SONG: Setting the scale for asteroseismic investigations

Context. We present the first high-cadence multiwavelength radial-velocity observations of the Sun-as-a-star, carried out during 57 consecutive days using the stellar échelle spectrograph at the Hertzsprung SONG Telescope operating at the Teide Observatory. Aims. Our aim was to produce a high-quality data set and reference values for the global helioseismic parameters $v_{\text{max}}$ and $\Delta v$ of the solar $p$-modes using the SONG instrument. The obtained data set or the inferred values should then be used when the scaling relations are applied to other stars showing solar-like oscillations observed with SONG or similar instruments. Methods. We used different approaches to analyse the power spectrum of the time series to determine $v_{\text{max}}$: simple Gaussian fitting and heavy smoothing of the power spectrum. We determined $\Delta v$ using the method of autocorrelation of the power spectrum. The amplitude per radial mode was determined using the method described in Kjeldsen et al. (2008, ApJ, 682, 1370). Results. We found the following values for the solar oscillations using the SONG spectrograph: $v_{\text{max}} = 3141 \pm 12 \mu$Hz, $\Delta v = 134.98 \pm 0.04 \mu$Hz, and an average amplitude of the strongest radial modes of $16.6 \pm 0.4 \text{ cm s}^{-1}$. These values are consistent with previous measurements with other techniques.
Patchy Lakes and Topographic Origin for Fast Flow in the Recovery Glacier System, East Antarctica

The Recovery subglacial basin, with its largest glacier Recovery Glacier, has been identified as potentially the biggest contributor to future sea level rise from East Antarctica. Subglacial lakes along the main trunk have been detected from satellite data, with four giant lakes (Recovery Lakes A, B, C, and D) located at the onset of the fast ice flow (≥15 m/yr) and multiple smaller lakes along the glacier. The presence of subglacial water potentially plays a key role in the control of fast ice flow of Recovery Glacier. We present new insights on the Recovery Lakes from airborne radar data collected in 2013 and 2015. Using an adjusted classification scheme, we show that a single large area consisting of smaller lakes connected by likely saturated sediment, referred to as Lake AB, exists in the originally proposed area of the Recovery Lakes A and B. We estimate that the current size of Lake AB is ~4,320 km². Water likely leaks from the western shore of Lake AB lubricating the bed initiating fast ice flow at this location. The difference in the outlines of Lake AB and the Lakes A and B previously derived from surface features suggested that a larger paleolake existed here in the past. From our data, we find Recovery Lake C to be dry; we attribute fast ice flow originating from this area to be due to a topographic step and thus an increase in ice thickness rather than enhanced lubrication at the bed.

General information
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Organisations: Geodynamics, National Space Institute, Norwegian Polar Institute, British Antarctic Survey, ESTEC
Corresponding author: Diez, A.
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Photodynamical analysis of the triply eclipsing hierarchical triple system EPIC 249432662

Using Campaign 15 data from the K2 mission, we have discovered a triply-eclipsing triple star system: EPIC 249432662. The inner eclipsing binary system has a period of 8.23 days, with shallow ~3% eclipses. During the entire 80-day campaign, there is also a single eclipse event of a third-body in the system that reaches a depth of nearly 50% and has a total duration of 1.7 days, longer than for any previously known third-body eclipse involving unevolved stars. The binary eclipses exhibit clear eclipse timing variations. A combination of photodynamical modeling of the lightcurve, as well as seven follow-up radial velocity measurements, has led to a prediction of the subsequent eclipses of the third star with a period of 188 days. A campaign of follow-up ground-based photometry was able to capture the subsequent pair of third-body events as well as two further 8-day eclipses. A combined photo-spectro-dynamical analysis then leads to the determination of many of the system parameters. The 8-day binary consists of a pair of M stars, while most of the system light is from a K star around which the pair of M stars orbits.

General information
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Organisations: National Space Institute, University of California at Berkeley, Hungarian Academy of Sciences, Massachusetts Institute of Technology, Raemor Vista Observatory, Harvard-Smithsonian Center for Astrophysics, California Institute of Technology, Perth Exoplanet Survey Telescope, NASA Goddard Space Flight Center, Ruhr-Universität Bochum, University of Texas at Austin
Postglacial gravity change in Fennoscandia – three decades of repeated absolute gravity observations
For the first time, we present a complete, processed compilation of all repeated absolute gravity (AG) observations in the Fennoscandian postglacial land uplift area and assess their ability to accurately describe the secular gravity change, induced by Glacial Isostatic Adjustment (GIA). The dataset spans over more than three decades and consists of 688 separate observations at 59 stations. Ten different organisations have contributed with measurements using 14 different instruments. The work was coordinated by the Nordic Geodetic Commission (NKG). Representatives from each country collected and processed data from their country, respectively, and all data were then merged to one dataset. Instrumental biases are considered and presented in terms of results from international comparisons of absolute gravimeters. From this dataset, gravity rates of change (g') are estimated for all stations with more than two observations and a timespan larger than two years. The observed rates are compared to predicted rates from a global GIA model as well as the state of the art semi-empirical land uplift model for Fennoscandia, NKG2016LU. Linear relations between observed g' and the land uplift, h' (NKG2016LU), are estimated from the absolute gravity observations by means of weighted least squares adjustment (WLSA) as well as weighted orthogonal distance regression (WODR). The empirical relations are not significantly different from the modelled, geophysical relation g'=0.03−0.163(±0.016)h'. We also present a g'-model for the whole Fennoscandian land uplift region. At many stations, the observational estimates of g' still suffer from few observations and/or unmodelled environmental effects (e.g. local hydrology). We therefore argue that, at present, the best predictions of GIA-induced gravity rate of change in Fennoscandia are achieved by means of the NKG2016LU land uplift model, together with the geophysical relation between g' and h'.

General information
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Contributors: Olsson, P., Breili, K., Ophaug, V., Steffen, H., Bilker-Koivula, M., Nielsen, E., Oja, T., Timmen, L.
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BFI (2019): BFI-level 1
Resolving Seasonal Ice Velocity of 45 Greenlandic Glaciers With Very High Temporal Details

Seasonal glacier ice velocities are important for understanding controlling mechanisms of ice flow. For many Greenlandic glaciers, however, these measurements are limited by low temporal resolution. We present seasonal ice velocity changes, melt season onset and extent, and ice front positions for 45 Greenlandic glaciers using 2015–2017 Sentinel-1 synthetic aperture radar data. Seasonal velocity fluctuations of roughly half of the glaciers appear to be primarily controlled by surface melt-induced changes in the subglacial hydrology. This includes (1) glaciers that speed up with the onset of surface melt and (2) glaciers with comparable late winter and early melt season velocities that show significant slowdown during most of the melt season and speedup during winter. In contrast, less than a quarter of the study glaciers show strong correspondence between seasonal ice speed and terminus changes. Our results pinpoint seasonal variations across Greenland, highlighting the variable influence of meltwater on year-round ice velocities.

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Organisations: Geodesy, National Space Institute, Microwaves and Remote Sensing, Geological Survey of Denmark and Greenland, University of Colorado Boulder, University of Copenhagen
Corresponding author: Vijay, S.
Contributors: Vijay, S., Khan, S. A., Kusk, A., Solgaard, A. M., Moon, T., Bjørk, A. A.
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Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review

Self-luminous and irradiated exoplanetary atmospheres explored with HELIOS
We present new methodological features and physical ingredients included in the one-dimensional radiative transfer code HELIOS, improving the hemispheric two-stream formalism. We conduct a thorough intercomparison survey with several established forward models, including COOLTLUSTY and PHOENIX, and find satisfactory consistency with their results. Then, we explore the impact of (i) different groups of opacity sources, (ii) a stellar path length adjustment, and (iii) a scattering correction on self-consistently calculated atmospheric temperatures and planetary emission spectra. First, we observe that temperature–pressure (T–P) profiles are very sensitive to the opacities included, with metal oxides, hydrides, and alkali atoms (and ionized hydrogen) playing an important role in the absorption of shortwave radiation (in very hot surroundings). Moreover, if these species are sufficiently abundant, they are likely to induce nonmonotonic T–P profiles. Second, without the stellar path length adjustment, the incoming stellar flux is significantly underestimated for zenith angles above 80°, which somewhat affects the upper atmospheric temperatures and the planetary emission. Third, the
scattering correction improves the accuracy of the computation of the reflected stellar light by ~10%. We use HELIOS to calculate a grid of cloud-free atmospheres in radiative–convective equilibrium for self-luminous planets for a range of effective temperatures, surface gravities, metallicities, and C/O ratios to be used by planetary evolution studies. Furthermore, we calculate dayside temperatures and secondary eclipse spectra for a sample of exoplanets for varying chemistry and heat redistribution. These results may be used to make predictions on the feasibility of atmospheric characterizations with future observations.

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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, University of Bern
Contributors: Malik, M., Kitzmann, D., Mendonça, J. M., Grimm, S. L., Marleau, G., Linder, E. F., Tsai, S., Heng, K.
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Signatures of a jet cocoon in early spectra of a supernova associated with a γ-ray burst
Long γ-ray bursts are associated with energetic, broad-lined, stripped-envelope supernovae[1,2] and as such mark the death of massive stars. The scarcity of such events nearby and the brightness of the γ-ray burst afterglow, which dominates the emission in the first few days after the burst, have so far prevented the study of the very early evolution of supernovae associated with γ-ray bursts[3]. In hydrogen-stripped supernovae that are not associated with γ-ray bursts, an excess of high-velocity (roughly 30,000 kilometres per second) material has been interpreted as a signature of a choked jet, which did not emerge from the progenitor star and instead deposited all of its energy in a thermal cocoon[4]. Here we report multi-epoch spectroscopic observations of the supernova SN 2017iuk, which is associated with the γ-ray burst GRB 171205A. Our spectra display features at extremely high expansion velocities (around 115,000 kilometres per second) within the first day after the burst[5,6]. Using spectral synthesis models developed for SN 2017iuk, we show that these features are characterized by chemical abundances that differ from those observed in the ejecta of SN 2017iuk at later times. We further show that the high-velocity features originate from the mildly relativistic hot cocoon that is generated by an ultra-relativistic jet within the γ-ray burst expanding and decelerating into the medium that surrounds the progenitor star[7,8]. This cocoon rapidly becomes transparent[9] and is outshone by the supernova emission, which starts to dominate the emission three days after the burst.

General information
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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, Kyoto University, University of Rome La Sapienza, Stockholm University, Adam Mickiewicz University in Poznan, Max-Planck-Institut fur extraterrestrische Physik, Thüringer Landessternwarte Tautenburg, National Institutes of Natural Sciences - National Astronomical Observatory of Japan, Osservatorio Astronomico di Brera, Clemson University, University of Amsterdam, George Washington University, University of Warwick, National Institute for Astrophysics, Weizmann Institute of Science, PSL Research University, CSIC, University of Copenhagen, Technical University of Denmark, University of Leicester
Corresponding author: Izzo, L.
Pages: 324-327
Publication date: 2019
So close, so different: characterization of the K2-36 planetary system with HARPS-N

Context. K2-36 is a K dwarf orbited by two small (\(R_b = 1.43 \pm 0.08 \, R_{\oplus}\) and \(R_c = 3.2 \pm 0.3 \, R_{\oplus}\)), close-in (\(a_b = 0.022\) au and \(a_c = 0.054\) au) transiting planets discovered by the Kepler/K2 space observatory. They are representatives of two distinct families of small planets (\(R_p < 4 \, R_{\oplus}\)) recently emerged from the analysis of Kepler data, with likely a different structure, composition and evolutionary pathways.

Aims. We revise the fundamental stellar parameters and the sizes of the planets, and provide the first measurement of their masses and bulk densities, which we use to infer their structure and composition.

Methods. We observed K2-36 with the HARPS-N spectrograph over \(\sim 3.5\) yr, collecting 81 useful radial velocity measurements. The star is active, with evidence for increasing levels of magnetic activity during the observing time span. The radial velocity scatter is \(\sim 17 \, m \, s^{-1}\) due to the stellar activity contribution, which is much larger that the semi-amplitudes of the planetary signals. We tested different methods for mitigating the stellar activity contribution to the radial velocity time variations and measuring the planet masses with good precision.

Results. We find that K2-36 is likely a \(\sim 1\) Gyr old system, and by treating the stellar activity through a Gaussian process regression, we measured the planet masses \(m_b = 3.9 \pm 1.1 \, M_{\oplus}\) and \(m_c = 7.8 \pm 2.3 \, M_{\oplus}\). The derived planet bulk densities \(\rho_b = 7.2^{-2.1+2.5} \, g \, cm^{-3}\) and \(\rho_c = 1.3^{-0.5+0.7} \, g \, cm^{-3}\) point out that K2-36 b has a rocky, Earth-like composition, and K2-36 c is a low-density sub-Neptune.

Conclusions. Composed of two planets with similar orbital separations but different densities, K2-36 represents an optimal laboratory for testing the role of the atmospheric escape in driving the evolution of close-in, low-mass planets after \(\sim 1\) Gyr from their formation. Due to their similarities, we performed a preliminary comparative analysis between the systems K2-36 and Kepler-36, which we deem worthy of a more detailed investigation.

SPT0346-52 is one of the most luminous and intensely star-forming galaxies in the universe, with and . In this paper, we present ALMA observations of the 158 μm emission line in this z = 5.7 dusty star-forming galaxy. We use a pixellated lensing reconstruction code to spatially and kinematically resolve the source-plane and rest-frame 158 μm dust continuum structure at ~700 pc (~012) resolution. We discuss the deficit with a pixellated study of the $L_{[C\ II]} / L_{\text{FIR}}$ ratio in the source plane. We find that individual pixels within the galaxy follow the same trend found using unresolved observations of other galaxies, indicating that the deficit arises on scales 700 pc. The lensing reconstruction reveals two spatially and kinematically separated components (~1 kpc and ~500 km s$^{-1}$ apart) connected by a bridge of gas. Both components are found to be globally unstable, with Toomre Q instability parameters everywhere. We argue that SPT0346-52 is undergoing a major merger, which is likely driving the intense and compact star formation.

General information
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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, University of Arizona, Universidad Diego Portales, Aix-Marseille University, Dalhousie University, European Southern Observatory, University of Florida, Flatiron Institute, Stanford University, University of California at Irvine, University of Illinois, Max-Planck-Institut fur Radioastronomie, University of Copenhagen
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Publication date: 2019
Peer-reviewed: Yes

TESS Discovery of an Ultra-short-period Planet around the Nearby M Dwarf LHS 3844

Data from the newly commissioned Transiting Exoplanet Survey Satellite has revealed a “hot Earth” around LHS 3844, an M dwarf located 15 pc away. The planet has a radius of 1.303± 0.022R⊕ and orbits the star every 11 hr. Although the existence of an atmosphere around such a strongly irradiated planet is questionable, the star is bright enough (I = 11.9, K = 9.1) for this possibility to be investigated with transit and occultation spectroscopy. The star’s brightness and the planet’s short period will also facilitate the measurement of the planet's mass through Doppler spectroscopy.

General information
Publication status: Published
Organisations: National Space Institute, Astrophysics and Atmospheric Physics, Aarhus University
Number of pages: 9
Publication date: 2019
Peer-reviewed: Yes
The ASIM Mission on the International Space Station
The Atmosphere-Space Interactions Monitor (ASIM) is an instrument suite on the International Space Station (ISS) for measurements of lightning, Transient Luminous Events (TLEs) and Terrestrial Gamma-ray Flashes (TGFs). Developed in the framework of the European Space Agency (ESA), it was launched April 2, 2018 on the SpaceX CRS-14 flight to the ISS. ASIM was mounted on an external platform of ESA’s Columbus module eleven days later and is planned to take measurements during minimum 3 years. The instruments are an x- and gamma-ray monitor measuring photons from 15 keV to 20 MeV, and an array of three photometers and two cameras measuring in bands at: 180–250 nm, 337 nm and 777.4 nm. Additional objectives that can be addressed with the instruments relate to space physics like aurorae and meteors, and to Earth observation such as dust- and aerosol effects on cloud electrification. The paper describes the scientific objectives of the ASIM mission, the instruments, the mission architecture and the international collaboration supported by the ASIM Science Data Centre. ASIM is the first space mission with a comprehensive suite of instruments designed to measure TLEs and TGFs. Two companion papers describe the instruments in more detail (Østgaard et al. in Space Sci. Rev., 2019; Chanrion et al. in Space Sci. Rev., 2019).

General information
Publication status: Published
Organisations: National Space Institute, Astrophysics and Atmospheric Physics, University of Bergen, University of Valencia, French Alternative Energies and Atomic Energy Commission, ESTEC, Terma AS
Number of pages: 17
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The Eclipsing δ Scuti Star EPIC 245932119

We present the physical properties of EPIC 245932119 (Kp = +9.82) exhibiting both eclipses and pulsations from the K2 photometry. The binary modeling indicates that the eclipsing system is in detached or semi-detached configurations with a mass ratio of 0.283 or 0.245, respectively, and that its light-curve parameters are almost unaffected by pulsations. Multiple frequency analyses were performed for the light residuals in the outside-primary eclipsing phase after subtracting the binarity effects from the observed data. We detected 35 frequencies with signal-to-noise amplitude ratios larger than 4.0 in two regions of 0.62-6.28 day\(^{-1}\) and 19.36-24.07 day\(^{-1}\). Among these, it is possible that some high signals close to the Nyquist limit f(Ny) may be reflections of real pulsation frequencies (2f(Ny) - f\(_i\)). All frequencies (f\(_9\), f\(_{14}\), f\(_{18}\), f\(_{24}\), f\(_{32}\)) in the lower frequency region are orbital harmonics, and three high frequencies (f\(_{19}\), f\(_{20}\), f\(_{22}\)) appear to be sidelobes split from the main frequency of f\(_i\) = 22.77503 day\(^{-1}\). Most of them are thought to be alias effects caused by the orbital frequency. For the 26 other frequencies, the pulsation periods and pulsation constants are in the ranges of 0.041-0.052 days and 0.013-0.016 days, respectively. These values and the position in the Hertzsprung-Russell diagram reveal that the primary component is a delta Scp pulsator. The observational properties of EPIC 245932119 are in good agreement with those for eclipsing binaries with delta Scp-type pulsating components.

The European Space Agency BIOMASS mission: Measuring forest above-ground biomass from space

The primary objective of the European Space Agency’s 7th Earth Explorer mission, BIOMASS, is to determine the worldwide distribution of forest above-ground biomass (AGB) in order to reduce the major uncertainties in calculations of carbon stocks and fluxes associated with the terrestrial biosphere, including carbon fluxes associated with Land Use Change, forest degradation and forest regrowth. To meet this objective it will carry, for the first time in space, a fully polarimetric P-band synthetic aperture radar (SAR). Three main products will be provided: global maps of both AGB and forest height, with a spatial resolution of 200m, and maps of severe forest disturbance at 50m resolution (where “global” is to be understood as subject to Space Object tracking radar restrictions). After launch in 2022, there will be a 3-month commissioning phase, followed by a 14-month phase during which there will be global coverage by SAR tomography. In the succeeding interferometric phase, global polarimetric interferometry Pol-InSAR coverage will be achieved every 7months up to the end of the 5-year mission. Both Pol-InSAR and TomoSAR will be used to eliminate scattering from the ground (both direct and double bounce backscatter) in forests. In dense tropical forests AGB can then be estimated from the remaining volume scattering using non-linear inversion of a backscattering model. Airborne campaigns in the tropics also indicate that AGB is highly correlated with the backscatter from around 30m above the ground, as measured by tomography. In contrast, double bounce scattering appears to carry important information about the AGB of boreal forests, so ground cancellation may not be appropriate and the best approach for such forests remains to be finalized. Several methods to exploit these new data in carbon cycle calculations have already been demonstrated. In addition, major mutual gains will be made by combining BIOMASS data with data from other missions that will measure forest biomass, structure, height and change, including the NASA Global Ecosystem Dynamics Investigation lidar deployed on the International Space Station after its launch in December 2018, and the NASA-ISRO NISAR L- and S-band SAR, due for launch in 2022.
More generally, space-based measurements of biomass are a core component of a carbon cycle observation and modelling strategy developed by the Group on Earth Observations. Secondary objectives of the mission include imaging of sub-surface geological structures in arid environments, generation of a true Digital Terrain Model without biases caused by forest cover, and measurement of glacier and icesheet velocities. In addition, the operations needed for ionospheric correction of the data will allow very sensitive estimates of ionospheric Total Electron Content and its changes along the dawn-dusk orbit of the mission.

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Organisations: National Space Institute, Microwaves and Remote Sensing, University of Sheffield, Universite Toulouse III - Paul Sabatier, University of Edinburgh, Paul Valery University of Montpellier, Politecnico di Milano, Universite de Bordeaux, German Aerospace Center, NASA Jet Propulsion Laboratory, European Space Research and Technology Centre (ESA/ESTEC), University of Virginia, Chalmers University of Technology, MJ Soja Consulting
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DOIs: 10.1016/j.rse.2019.03.032
Source: RIS
Source-ID: urn:846354091B054A5CC73EB9D1BF82A50E
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review

The Extremely Luminous Quasar Survey in the Sloan Digital Sky Survey Footprint. III. The South Galactic Cap Sample and the Quasar Luminosity Function at Cosmic Noon

We have designed the Extremely Luminous Quasar Survey (ELQS) to provide a highly complete census of unobscured UV-bright quasars during the cosmic noon, z = 2.8-5.0. Here we report the discovery of 70 new quasars in the ELQS South Galactic Cap (ELQS-S) quasar sample, doubling the number of known extremely luminous quasars in 4237.3 deg² of the Sloan Digital Sky Survey footprint. These observations conclude the ELQS and we present the properties of the full ELQS quasar catalog, containing 407 quasars over 11,838.5 deg². Our novel ELQS quasar selection strategy resulted in unprecedented completeness at the bright end and allowed us to discover 109 new quasars in total. This marks an increase of similar to 36% (109/298) in the known population at these redshifts and magnitudes, while we further are able to retain a selection efficiency of similar to 80%. On the basis of 166 quasars from the full ELQS quasar catalog, which adhere to the uniform criteria of the Two Micron All Sky Survey point source catalog, we measure the bright-end quasar luminosity function (QLF) and extend it one magnitude brighter than previous studies. Assuming a single power law with exponential density evolution for the functional form of the QLF, we retrieve the best-fit parameters from a maximum likelihood analysis. We find a steep bright end slope of beta approximate to -4.1, and we can constrain the bright-end slope to β ≤ -3.4 with 99% confidence. The density is well modeled by the exponential redshift evolution, resulting in a moderate decrease with redshift (γ ≈ -0.4).

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The Modular Multispectral Imaging Array (MMIA) of the ASIM Payload on the International Space Station

The Modular Multispectral Imaging Array (MMIA) is a suite of optical sensors mounted on an external platform of the European Space Agency’s Columbus Module on the International Space Station. The MMIA, together with the Modular X- and Gamma-ray Sensor (MXGS), are the two main instruments forming the Atmosphere-Space Interactions Monitor (ASIM). The primary scientific objectives of the ASIM mission are to study thunderstorm electrical activity such as lightning, Transient Luminous Emissions (TLEs) and Terrestrial Gamma-ray Flashes (TGFs) by observing the associated emissions in the UV, near-infrared, x- and gamma-ray spectral bands. The MMIA includes two cameras imaging in 337 nm and 777.4 nm, at up to 12 frames per second, and three high-speed photometers at 180–230 nm, 337 nm and 777.4 nm, sampling at rates up to 100 kHz. The paper describes the MMIA and the aspects that make it an essential tool for the study of thunderstorms. The mission architecture is described in Neubert et al. (Space Sci. Rev. 215:26, 2019, this issue) and the MXGS instruments in Østgaard et al. (Space Sci. Rev. 215:23, 2019, this issue).

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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, Measurement and Instrumentation Systems, Microwaves and Remote Sensing, Department of Photonics Engineering, Coding and Visual Communication, Terma AS
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Source: FindIt
Source-ID: 2446300829
Research output: Contribution to journal » Journal article – Annual report year: 2019 » Research » peer-review
The Modular X- and Gamma-Ray Sensor (MXGS) of the ASIM Payload on the International Space Station

The Modular X- and Gamma-ray Sensor (MXGS) is an imaging and spectral X- and Gamma-ray instrument mounted on the starboard side of the Columbus module on the International Space Station. Together with the Modular Multi-Spectral Imaging Assembly (MMIA) (Chanrion et al. this issue) MXGS constitutes the instruments of the Atmosphere-Space Interactions Monitor (ASIM) (Neubert et al. this issue). The main objectives of MXGS are to image and measure the spectrum of X- and γ-rays from lightning discharges, known as Terrestrial Gamma-ray Flashes (TGFs), and for MMIA to image and perform high speed photometry of Transient Luminous Events (TLEs) and lightning discharges. With these two instruments specifically designed to explore the relation between electrical discharges, TLEs and TGFs, ASIM is the first mission of its kind. With an imaging system and a large detector area MXGS will, for the first time, allow estimation of the location of the source region and characterization of the energy spectrum of individual events. The sensors have fast readout electronics to minimize pileup effects, giving high time resolution of photon detection for comparison with measurements on μs-time scales of lightning processes measured by the MMIA and other sensors in space or on the ground. The detectors cover the large energy range of the relevant photon energies. In this paper we describe the scientific objectives, design, performance, imaging capabilities and operational modes of the MXGS instrument.

General information

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Source-ID: 2444066588
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review

The X-shooter GRB afterglow legacy sample (XS-GRB)
In this work we present spectra of all γ-ray burst (GRB) afterglows that have been promptly observed with the X-shooter spectrograph until 31/03/2017. In total, we have obtained spectroscopic observations of 103 individual GRBs observed within 48 hours of the GRB trigger. Redshifts have been measured for 97 per cent of these, covering a redshift range from 0.059 to 7.84. Based on a set of observational selection criteria that minimise biases with regards to intrinsic properties of the GRBs, the follow-up effort has been focused on producing a homogeneously selected sample of 93 afterglow spectra for GRBs discovered by the Swift satellite. We here provide a public release of all the reduced spectra, including continuum estimates and telluric absorption corrections. For completeness, we also provide reductions for the 18 late-time observations of the underlying host galaxies. We provide an assessment of the degree of completeness with respect to the parent GRB population, in terms of the X-ray properties of the bursts in the sample and find that the sample presented
here is representative of the full Swift sample. We have constrained the fraction of dark bursts to be <28 per cent and confirm previous results that higher optical darkness is correlated with increased X-ray absorption. For the 42 bursts for which it is possible, we have provided a measurement of the neutral hydrogen column density, increasing the total number of published HI column density measurements by ~33 per cent. This dataset provides a unique resource to study the ISM across cosmic time, from the local progenitor surroundings to the intervening Universe.

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Organisations: National Space Institute, Astrophysics and Atmospheric Physics, Max-Planck-Institut fur extraterrestrische Physik, Osservatorio Astronomico Roma, Osservatorio Astronomico di Brera, Italian Space Agency, PSL Research University, Royal Institute of Technology, University of Nova Gorica, Radboud University Nijmegen, University of Amsterdam, University of Warwick, CNRS, Liverpool John Moores University, National Institute for Astrophysics, University of Calabria, Weizmann Institute of Science, Stockholm University, University of Potsdam, Technical University of Denmark, Chinese Academy of Sciences, Australian Astronomical Observatory, Universite Paris-Saclay, Universite Paris 7, CSIC, University of Copenhagen, European Southern Observatory, University of Iceland, University of Leicester
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Electronic versions: marac_aa34522_18.pdf
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Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review

**Three dimensional polarimetric neutron tomography-beyond the phase-wrapping limit**
Three dimensional polarimetric neutron tomography is an emerging method for non-destructive investigation of magnetic field strength and direction distribution in three dimensions. It utilises the Larmor precession of the neutron spin in the presence of an external magnetic field and has so far been restricted to the measurement of magnetic fields weak enough to keep the neutron precession below the phase-wraping limit at 180°. Through the use of polychromatic time-of-flight information in combination with an iterative forward model reconstruction algorithm we have gone beyond this limit, thereby vastly broadening the potential of the technique. We present the reconstructed magnetic field of a measured current carrying solenoid as a proof-of-principle for this novel method, as well as successfully applying the method to a simulated data set of a sample consisting of multiple magnetic domains.

**General information**
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Organisations: Neutrons and X-rays for Materials Physics, Department of Physics, Imaging and Structural Analysis, Department of Energy Conversion and Storage, Optofluidics, National Space Institute, Japan Atomic Energy Agency, University of California at Berkeley, Paul Scherrer Institute
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Contributors: Sales, M., Shinozawa, T., Sørensen, M. K., Knudsen, E. B., Tremsin, A., Strobl, M., Schmidt, S.
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Time-dependent low-latitude core flow and geomagnetic field acceleration pulses

We present a new model of time-dependent flow at low latitudes in the Earth's core between 2000 and 2018 derived from magnetic field measurements made on board the Swarm and CHAMP satellites and at ground magnetic observatories. The model, called CoreFlo-LL, consists of a steady background flow without imposed symmetry plus a time-dependent flow that is dominated by geostrophic and quasi-geostrophic components but also allows weak departures from equatorial symmetry. Core flow mode amplitudes are determined at 4-month intervals by a robust least-squares fit to ground and satellite secular variation data. The L1 norm of the square root of geostrophic and inertial mode enstrophies, and the L2 norm of the flow acceleration, are minimized during the inversion procedure. We find that the equatorial region beneath the core–mantle boundary is a place of vigorous, localized, fluid motions; time-dependent flow focused at low latitudes close to the core surface is able to reproduce rapid field variations observed at non-polar latitudes at and above Earth's surface. Magnetic field acceleration pulses are produced by alternating bursts of non-zonal azimuthal flow acceleration in this region. Such bursts are prominent in the longitudinal sectors from 80–130°E and 60–100°W throughout the period studied, but are also evident under the equatorial Pacific from 130°E to 150°W after 2012. We find a distinctive interannual alternation in the sign of the non-zonal azimuthal flow acceleration at some locations involving a rapid crossover between flow acceleration convergence and divergence. Such acceleration sign changes can occur within a year or less and, when the structures involved are of large spatial extent, they can give rise to geomagnetic jerks at the Earth's surface. For example, in 2014, we find a change in the sign of the non-zonal azimuthal flow acceleration under the equatorial Pacific as a region of flow acceleration divergence near 130°E changes to a region of flow acceleration convergence. This occurs at a maximum in the amplitude of the time-varying azimuthal flow under the equatorial Pacific and corresponds to a geomagnetic jerk at the Earth's surface.
Time-predictable synchronization support with a shared scratchpad memory

Multicore processors need to communicate when working on shared tasks. In classical systems, this is performed via shared objects protected by locks, which are implemented with atomic operations on the main memory. However, access to shared main memory is already a bottleneck for multicore processors. Furthermore, the access time to a shared memory is often hard to predict and therefore problematic for real-time systems. This paper presents a shared on-chip memory that is used for communication and supports atomic operations to implement locks. Access to the shared memory is arbitrated with time division multiplexing, providing time-predictable access. The shared memory supports extended time slots so that a processor can execute more than one memory operation atomically. This allows for the implementation of locking and other synchronization primitives. We evaluate this shared scratchpad memory with synchronization support on a 9-core version of the T-CREST multicore platform. Worst-case access latency to the shared scratchpad is 13 clock cycles. Access to the atomic section under full contention, when every processor core wants access to acquire a lock, is 135 clock cycles.

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Organisations: Department of Photonics Engineering, National Space Institute, Coding and Visual Communication, Department of Applied Mathematics and Computer Science, Embedded Systems Engineering, Technical University of Denmark
Contributors: Maroun, E. J., Hansen, H. E., Kristensen, A. T., Schoeberl, M.
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Source: FindIt
Source-ID: 2440149690
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Version 2 of the EUMETSAT OSI SAF and ESA CCI sea-ice concentration climate data records

We introduce the OSI-450, the SICCl-25km and the SICCI-50km climate data records of gridded global sea-ice concentration. These three records are derived from passive microwave satellite data and offer three distinct advantages compared to existing records: first, all three records provide quantitative information on uncertainty and possibly applied filtering at every grid point and every time step. Second, they are based on dynamic tiepoints, which capture the time evolution of surface characteristics of the ice cover and accommodate potential calibration differences between satellite missions. Third, they are produced in the context of sustained services offering committed extension, documentation, traceability, and user support. The three records differ in the underlying satellite data (SMMR & SSM/I & SSMIS or AMSR-E & AMSR2), in the imaging frequency channels (37 GHz and either 6 or 19 GHz), in their horizontal resolution (25 or 50 km), and in the time period they cover. We introduce the underlying algorithms and provide an evaluation. We find that all three records compare well with independent estimates of sea-ice concentration both in regions with very high sea-ice concentration and in regions with very low sea-ice concentration. We hence trust that these records will prove helpful for a better understanding of the evolution of the Earth’s sea-ice cover.

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