Seminar 1
Session 03: Structure of a scientific paper

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Structure of a scientific paper

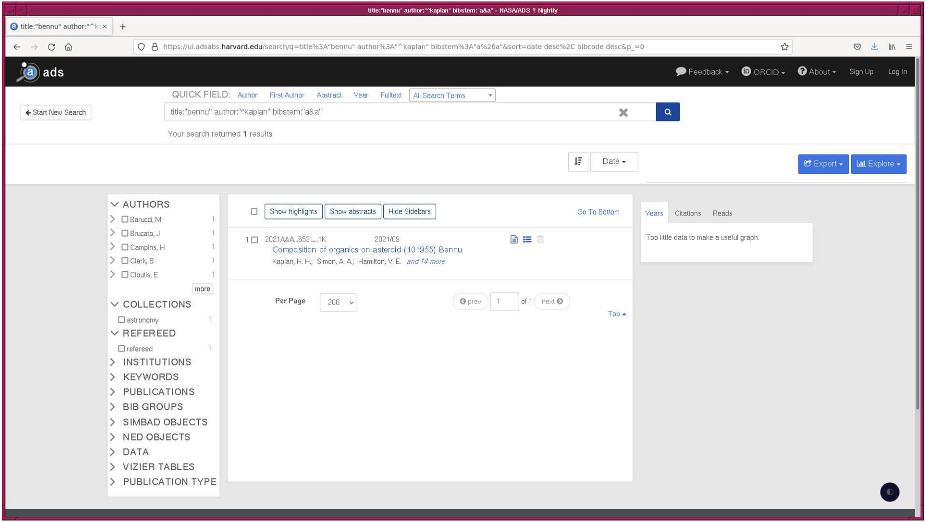
- Information on the first page
  - title
  - names of authors
  - addresses of authors' institution
  - abstract
  - keywords

An example

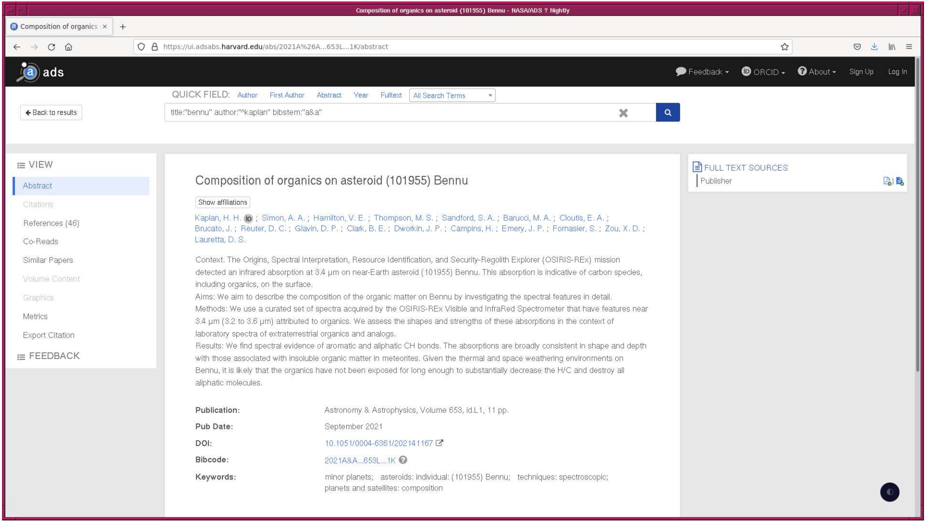
- We take a look at following paper as an example.
  - Astronomy & Astrophysics (Volume 653, September 2021)
    - "Composition of organics on asteroid (101955) Bennu"
    - Kaplan et al., 2021, A&A, 653, L1.
    - `https://doi.org/10.1051/0004-6361/202141167`
- If you use ADS to find the paper, try following.

title:"bennu" author:"^kaplan" bibstem:"a&a"

Kaplan et al. 2021



Kaplan et al. 2021



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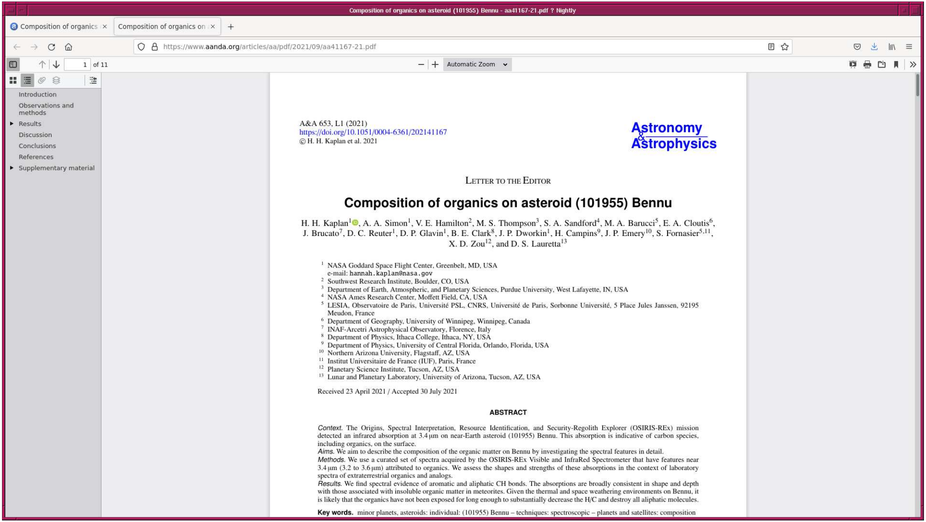

A&A 653, L1 (2021)
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Astronomy & Astrophysics

Letter to the Editor

Composition of organics on asteroid (101955) Bennu

H. H. Kaplan[1], A. A. Simon[1], V. E. Hamilton[2], M. S. Thompson[3], S. A. Sandford[4], M. A. Barucci[5], E. A. Cloutis[6], J. Brucato[7], D. C. Reuter[1], D. P. Glavin[1], B. E. Clark[8], J. P. Dworkin[1], H. Campins[9], J. P. Emery[10], S. Fornasier[5,11], X. D. Zou[12], and D. S. Lauretta[13]

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Received 23 April 2021 / Accepted 30 July 2021

ABSTRACT

Context. The Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) mission detected an infrared absorption at 3.4 μm on near-Earth asteroid (101955) Bennu. This absorption is indicative of carbon species, including organics, on the surface.
Aims. We aim to describe the composition of the organic matter on Bennu by investigating the spectral features in detail.
Methods. We use a curated set of spectra acquired by the OSIRIS-REx Visible and InfraRed Spectrometer that have features near 3.4 μm (3.2 to 3.6 μm) attributed to organics. We assess the shapes and strengths of these absorptions in the context of laboratory spectra of extraterrestrial organics and analogs.
Results. We find spectral evidence of aromatic and aliphatic CH bonds. The absorptions are broadly consistent in shape and depth with those associated with insoluble organic matter in meteorites. Given the thermal and space weathering environments on Bennu, it is likely that the organics have not been exposed for long enough to substantially decrease the H/C and destroy all aliphatic molecules.

Key words. minor planets, asteroids: individual: (101955) Bennu – techniques: spectroscopic – planets and satellites: composition

First page of a paper

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Key words. minor planets, asteroids: individual: (101955) Bennu – techniques: spectroscopic – planets and satellites: composition

1. Introduction

The Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) mission detected carbon species, including organics and carbonates, on near-Earth asteroid (101955) Bennu (Kaplan et al. 2020; Simon et al. 2020a). These findings, based on the presence of an infrared absorption near 3.4 µm, indicate that the sample of Bennu's regolith that the OSIRIS-REx spacecraft will return to Earth total carbon in organic and inorganic forms (Pearson et al. 2006; Alexander et al. 2012; Sephton 2002). The majority of the meteoritic carbon (>70 wt.%) is hosted in insoluble organic matter (IOM): an acid-insoluble kerogen-like macromolecule that is structurally complex, with variable isotopic and elemental compositions (Cody & Alexander 2005; Alexander et al. 2017). The soluble organic matter (SOM) represents a much smaller fraction (up to 0.1%) of the total carbon, with the remainder of carbon either unaccounted for with current techniques

Structure of main body of a paper

- Structure of main body of a paper
  - Introduction
  - Observations or calculations or mathematical derivations
  - Results
  - Discussion
  - Conclusions
- Basically, structure of a paper is similar to that of a scientific report.
  - Introduction
  - Methods
  - Results
  - Discussion
  - Conclusions
- You have written many scientific reports after doing experiments when you were undergraduate students, right?

Introduction part of a paper

with those associated with insoluble organic matter in meteorites. Given the thermal and space weathering environments on Bennu, it is likely that the organics have not been exposed for long enough to substantially decrease the H/C and destroy all aliphatic molecules.

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1. Introduction

The Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) mission detected carbon species, including organics and carbonates, on near-Earth asteroid (101955) Bennu (Kaplan et al. 2020; Simon et al. 2020a). These findings, based on the presence of an infrared absorption near 3.4 μm, indicate that the sample of Bennu's regolith that the OSIRIS-REx spacecraft will return to Earth in 2023 (Lauretta et al. 2021, 2017) is likely to contain carbon-bearing material. The organic component may hold clues to the conditions of the early Solar System and the origins of life on Earth (e.g., Chyba et al. 1990).

Bennu has been spectrally linked to aqueously altered CI- and CM-type carbonaceous chondrites (Clark et al. 2011; Hamilton et al. 2019); these primitive carbon-rich meteorites are likely the closest analogs of Bennu currently available for laboratory studies. CI and CM chondrites contain 1 to 5 wt.% total carbon in organic and inorganic forms (Pearson et al. 2006; Alexander et al. 2012; Sephton 2002). The majority of the meteoritic carbon (>70 wt.%) is hosted in insoluble organic matter (IOM): an acid-insoluble kerogen-like macromolecule that is structurally complex, with variable isotopic and elemental compositions (Cody & Alexander 2005; Alexander et al. 2017). The soluble organic matter (SOM) represents a much smaller fraction (up to 0.1%) of the total carbon, with the remainder of carbon either unaccounted for with current techniques or contained in inorganic forms (e.g., carbonates and nanodiamonds). Meteoritic SOM can be highly complex, with a variety of different compound classes, such as amino acids, carboxylic acids, hydroxy acids, amines, alcohols, aldehydes, ketones, N-heterocycles, polyols, aliphatic and aromatic hydrocarbons, and sugars (e.g., Glavin et al. 2018).

Most of the meteoritic organic matter likely originated in the interstellar medium or in the colder regions of the protoplanetary disk before being incorporated into the earliest Solar

Observations and Results parts of a paper

groups have been attributed to nebular processes, thermal and/or aqueous alteration of the parent body (e.g., Herd et al. 2011; Alexander et al. 2007; Glavin et al. 2010), and surface modification, such as space weathering (e.g., Thompson et al. 2020).

2. Observations and methods

The OSIRIS-REx Visible and InfraRed Spectrometer (OVIRS; Reuter et al. 2018) has a circular, 4 mrad field of view. It collected tens of thousands of spectra of Bennu with wavelengths from 0.4 to 4.3 µm. In the wavelength region near 3.4 µm (3.2 to 3.6 µm), there are at least four absorption characteristic of organic carbon, resulting from the symmetric and asymmetric stretching modes of methyl (-CH_3) and methylene (-CH_2) groups (i.e., aliphatic CH; e.g., Allen & Wickramasinghe 1981; Pendleton 1995).

We analyzed spectra collected during the sample site reconnaissance (Recon A) phase of the OSIRIS-REx mission in October 2019 (Lauretta et al. 2021, 2017). The Recon A data set in this study comprises 15 585 photometrically corrected OVIRS spectra that cover 10% of the surface; it focuses on regions of interest, including the Nightingale site (Hokioi crater), where OSIRIS-REx collected its sample (see Appendix A for more observation details and coverage map). We used these data, rather than the global-coverage data set at 20 m per footprint (Simon et al. 2020a), because the spatial resolution (4−5 m cross-track and 7−10 m along-track) is optimized to isolate at 3.42 µm has been linked to the composition and concentration of organic matter in sedimentary rocks and meteorites (e.g., Herron et al. 2014; Kaplan & Milliken 2018). For IOM extracted from carbonaceous chondrites, band depth is positively correlated with the hydrogen-to-carbon ratio (H/C; Kaplan et al. 2019). If there is not enough hydrogen in the organics (i.e., $H/C < 0.3$), there will be no absorption at 3.42 µm. For IOM in bulk rock (i.e., meteorites), the absolute concentration is also important: >1 wt.% C is needed to observe an absorption at 3.42 µm (Kaplan et al. 2019). Most CMs and CIs contain 1−3 wt.% C and have bulk H/C ratios in the IOM > 0.5 (Alexander et al. 2007).

3. Results

3.1. Spectral features

Most OVIRS spectra appear to be a mixture of organic and carbonate material, which is not suitable for our analysis. In total, only 237 of the 15 585 spectra analyzed are well fit by the organic laboratory spectra described in Sect. 2 ($\chi^2 < 2$; see Appendix A). We refer to these hereafter as organic-rich spectra because they have absorption band positions and widths that match laboratory organic spectra (Fig. 1). These organic-rich spectra are distributed across the asteroid surface (i.e., are not concentrated in any given region), suggesting a wide spatial distribution of organics (Ferrone et al. 2021). The spectral features themselves are not homogenous and have varying absorp-

Discussion part of a paper

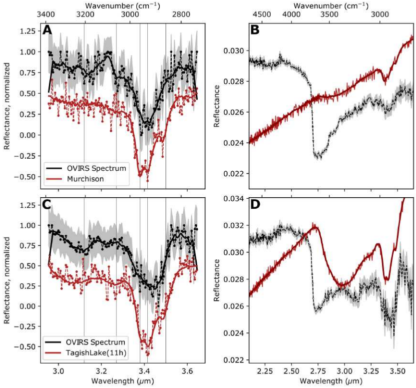

Fig. 2. Laboratory spectral matches for organic spectral shapes observed on Bennu. The most common spectral shapes in the Bennu spectra that we analyzed are well matched with spectra of meteorite IOM. (*a*) and (*c*) Best fits in the 3.1 to 3.6 μm region between the OVIRS spectra (black) and the IOM spectra (red, solid), with noised added to simulate OVIRS noise (red, dashed); the spectra are normalized from 0 to 1 and

4. Discussion

The spectral features from 2.9 to 3.6 μm observed on Bennu allow us to compare this asteroid to other extraterrestrial settings. The OVIRS data are comparable to the spectra seen in the diffuse interstellar medium (Allen & Wickramasinghe 1981; Sandford et al. 1991), comet 67P (Raponi et al. 2020), and multiple large main-belt asteroids (Simon et al. 2020a). We find that carbonaceous chondrite IOM is the closest laboratory analog to Bennu's organics based on the available spectral data at the wavelengths covered by the OVIRS instrument. This finding strengthens the previously described connection between Bennu and carbonaceous chondrite meteorites (Clark et al. 2011; Hamilton et al. 2019, 2021). The macroscale heterogeneity of the organic-rich spectra of Bennu has not been observed elsewhere in the Solar System (potentially owing to a lack of spacecraft data in most cases) but is mirrored in the large heterogeneity seen at small scales in meteorite organics (e.g., Alexander et al. 2017).

The organics on Bennu may reflect heterogenous aqueous alteration conditions. Although aqueous alteration has been reported to decrease H/C (Herd et al. 2011), the modification of organics is primarily controlled by heating (Alexander et al. 2014; Quirico et al. 2018), and the variation in H/C and C wt.% estimated for organic-rich OVIRS spectra may be the result of variable heating (Fig. 3). Typically, higher H/C values are also associated with higher N/C, O/C, and bulk C (Alexander et al. 2007). Though spectra with a feature near 3.1 μm may indicate

Conclusions part of a paper

2021). Thus, the space weathering of organics may result in competitive spectral trends, depending on the dominant constituent processes, initial composition, and/or the timescales of surface exposure.

The potential for the rapid breakdown of aliphatic organics would indicate that where these compounds are observed on Bennu, the surface has been exposed for a relatively short period of time. Spectrophotometric studies suggest that Bennu's small craters may be less than tens of thousands of years old (DellaGiustina et al. 2020). In addition, evidence of particle ejection and re-impact (Lauretta et al. 2019) and thermally driven fracturing (Molaro et al. 2020) on Bennu indicates that ongoing surface processes are continually exposing fresh material at the surface.

5. Conclusions

The detection of organic matter on asteroid Bennu using the OVIRS instrument on board the OSIRIS-REx spacecraft provides a preview of the composition of the sample that will be returned to Earth in 2023. Spectral features near 3.4 µm, including a strong absorption minimum between 3.38 and 3.42 µm and a possible shoulder at 3.3 µm, are indicative of aliphatic and aromatic CH with a maximum H/C of 0.6 and a minimum H/C of 0.3. The overall spectral shape in the OVIRS data is most comparable to meteorite IOM, as opposed to other organic soluble organic diversity and composition.

Acknowledgements. We are grateful to the entire OSIRIS-REx Team for making the encounter with Bennu possible. This material is based upon work supported by NASA under Contract NNM10AA11C issued through the New Frontiers Program. OVIRS spectral data from Recon A are available via the Planetary Data System at `https://sbn.psi.edu/pds/resource/orex/ovirs.html` (Reuter et al. 2019). Data are delivered to the PDS according to the schedule in the OSIRIS-REx Data Management Plan, available in the OSIRIS-REx mission bundle at `https://sbnarchive.psi.edu/pds4/orex/orex.mission/document/`.

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Figure in a paper

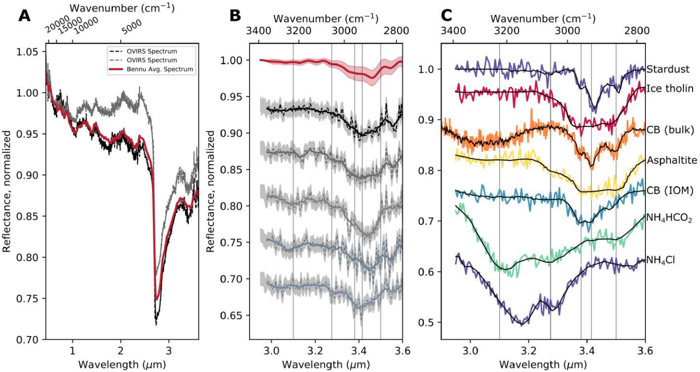

Fig. 1. Evidence of organics on Bennu in spectral features near 3.4 µm. (*a*) Average OVIRS spectrum of Bennu (red) and two OVIRS spectra of Bennu with spectral features near 3.4 µm. (*b*) Close-up of the continuum-removed region around 3.4 µm, offset, with wavelengths of C-H absorptions indicated by vertical gray lines. The top three spectra are the same as those shown in panel a. The shaded region indicates uncertainties, and the vertical lines at 3.10, 3.275, 3.38, 3.42, and 3.50 µm indicate positions of possible absorption features. (*c*) Laboratory spectra near 3.4 µm for comparison. Black lines are the spectra, and colors are spectra with noise added to simulate OVIRS noise. "CB" stands for "Cold Bokkeveld", "bulk" refers to the whole meteorite, and "IOM" refers to the extracted insoluble organic component.

Table in a paper

Table 3. Molecular surface density at 250 au derived with DiskFit.

Molecules		Surface density (cm^{-2})	Molecules		Surface density (cm^{-2})
^{13}CO	D	1.10×10^{16} (*)	CS	D	$(2.6 \pm 0.03) \times 10^{13}$
$C^{18}O$	D	2.42×10^{15} (*)	^{13}CS	D	$(2.6 \pm 0.7) \times 10^{11}$
$^{13}C^{17}O$	U	$<1.2 \times 10^{13}$	CCS	D	$(1.5 \pm 0.2) \times 10^{12}$
CN	D	$(7.7 \pm 0.1) \times 10^{13}$	OCS	M	$(4.5 \pm 2.3) \times 10^{10}$
^{13}CN	D	$(2.8 \pm 1.1) \times 10^{12}$	p/o-H_2CS	U	$<8.2 \times 10^{13}/5.3 \times 10^{12}$
CCH	D	$(6.8 \pm 0.1) \times 10^{13}$	SO	U	$<4.5 \times 10^{12}$
N_2H^+	D	$(1.2 \pm 0.1) \times 10^{12}$	SO_2	U	$<5.0 \times 10^{12}$
N_2D^+	U	$<1.3 \times 10^{11}$	SiO	U	$<4.5 \times 10^{11}$
HCN	D	$(6.70 \pm 0.04) \times 10^{12}$	DCN	M	$(1.9 \pm 1.2) \times 10^{11}$
$H^{13}CN$	U	$<1.6 \times 10^{11}$	CCD	U	$<1.0 \times 10^{14}$
$HC^{15}N$	U	$<2.9 \times 10^{11}$	HDO	U	$<1.9 \times 10^{10}$
HNC	D	$(3.4 \pm 0.03) \times 10^{12}$	DNC	D	$(2.7 \pm 0.7) \times 10^{11}$
$HN^{13}C$	U	$<1.7 \times 10^{11}$	D_2CO	U	$<1.6 \times 10^{10}$
HCO^+	D	$(1.50 \pm 0.01) \times 10^{13}$	DCO^+	M	$(2.2 \pm 0.7) \times 10^{11}$
$H^{13}CO^+$	D	$(4.0 \pm 0.2) \times 10^{11}$	p-H_2CO	D	$(3.6 \pm 0.2) \times 10^{12}$
HOC^+	U	$<3.2 \times 10^{10}$	c-C_3H_2	U	$<1.0 \times 10^{12}$
$HCNH^+$	U	$<2.2 \times 10^{13}$	HC_3N	D	$(5.4 \pm 1.1) \times 10^{11}$
HCCCHO	U	$<1.4 \times 10^{17}$	CH_3CN	U	$<2.5 \times 10^{11}$
$C^{34}S$	D	$(1.0 \pm 0.1) \times 10^{12}$			

Notes. The temperature uncertainty only affects the derived densities by factors smaller than 2. D = detected, U = undetected, and M = marginal detected $T_0 = 15$ K for S-bearing species, and $T_0 = 25$ K for all other molecules. (*)The values are taken from Phuong et al. (2020).

Table 4. Molecular abundance with respect to ^{13}CO: $10^5 \times (X_{mol}/X_{^{13}CO})$.

Mol.	TMC-1	LkCa 15	GG Tau	Mol.	TMC-1	LkCa 15	GG Tau
$C^{18}O$	1.1×10^4 (1)	2.8×10^4 (7)	2.2×10^4	$C^{34}S$	...	...	10 ± 1
CN	2250 (1)	3100 (8)	660 ± 30	CS	1500 (3)	520 (8)	230 ± 10
^{13}CN	...	...	25 ± 10	^{13}CS	11 (4)	2.8 (10)	2.2 ± 0.6
CCH	5960 (2)	1200 (8)	600 ± 30	CCS	240 (3)	...	13 ± 2
N_2H^+	7680 (1)	19.1 (9)	10.5 ± 0.5	OCS	1500 (1)	...	0.4 ± 0.2
HCN	1500 (2)	300 (8)	57 ± 3	DCN	22 (6)	7.5 (9)	1.6 ± 1.0
HNC	1500 (2)	...	29 ± 2	DNC	124 (6)	3.5 (9)	2.3 ± 1.1
HCO^+	596 (2)	350 (8)	125 ± 5	DCO^+	30 (5)	4.5 (11)	3.5 ± 0.2 (13)
$H^{13}CO^+$	8.3 (1)	5.0 (12)	3.4 ± 0.2				
H_2CO	1500 (2)	13.6 (9)	33 ± 2 (*)	HC_3N	473 (2)	7.3 (12)	4.6 ± 0.9

Notes. (*)For para-H_2CO only in GG Tau. Since estimating the uncertainties from all of these different studies was very difficult, we do not quote them for TMC1 and LkCa15.

References. (1)Dutrey et al. (1997), (2)Omont (2007), (3)Cernicharo et al. (2021), (4)Liszt & Ziurys (2012), (5)Butner et al. (1995), (6)Turner (2001), (7)Qi et al. (2003), (8)Guilloteau et al. (2016), (9)Loomis et al. (2020), (10)Le Gal et al. (2019), (11)Huang et al. (2017), (12)Chapillon et al. (2012), (13)Phuong et al. (2018).

4. Discussion

4.1. Sulphur in protoplanetary disk: First detection of CCS

Beyond CS, only a few S-bearing species observed in molecular

Acknowledgements

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Format of references

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    - The paper is written by Alexander, Fogel, Yabuta, and Cody.
    - The paper was published in 2007.
    - The paper was published on the journal "Geochimica et Cosmochimica Acta"
    - The paper is on the volume number 71.
    - The paper is on the page number 4380.

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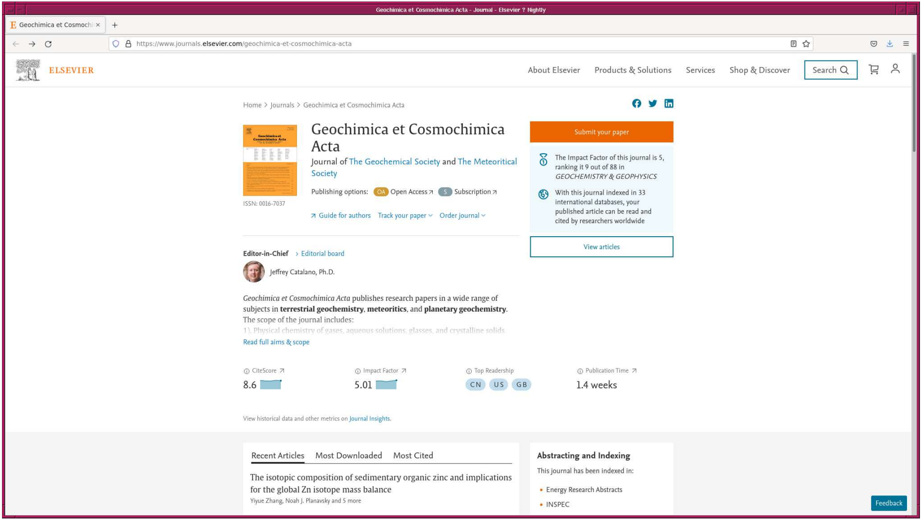

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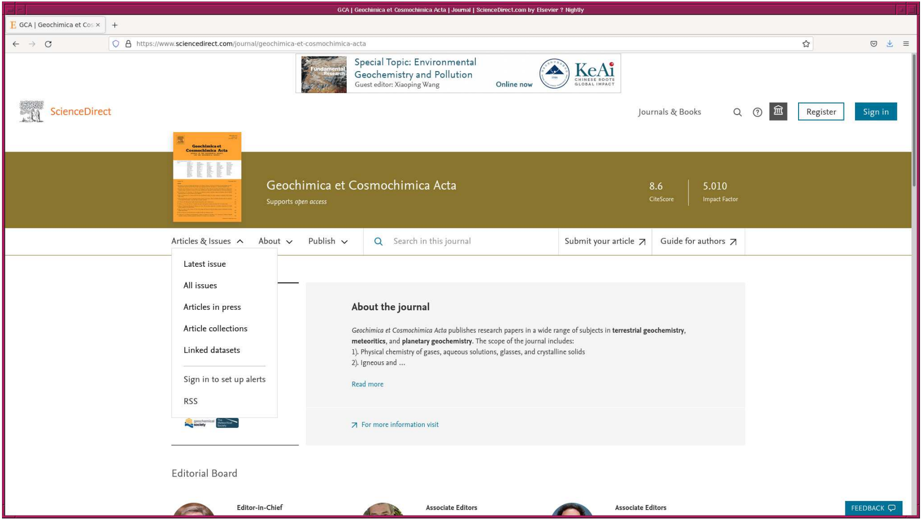

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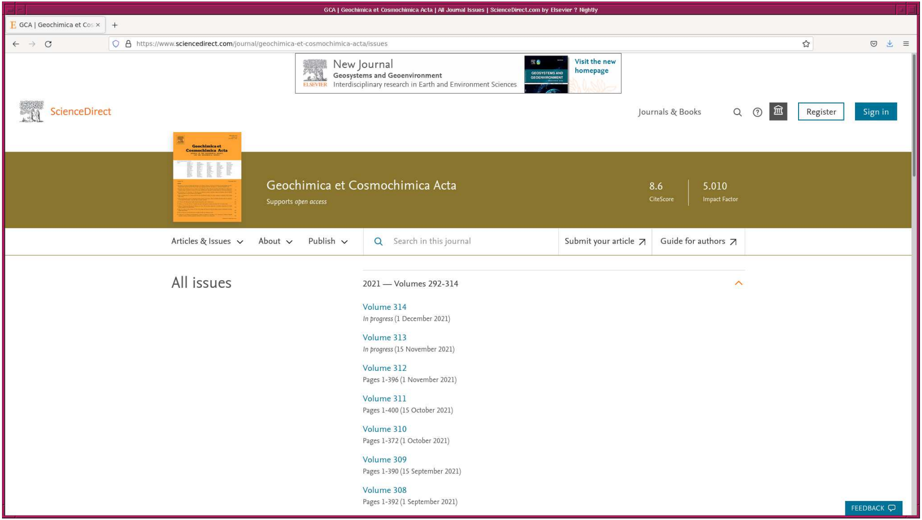

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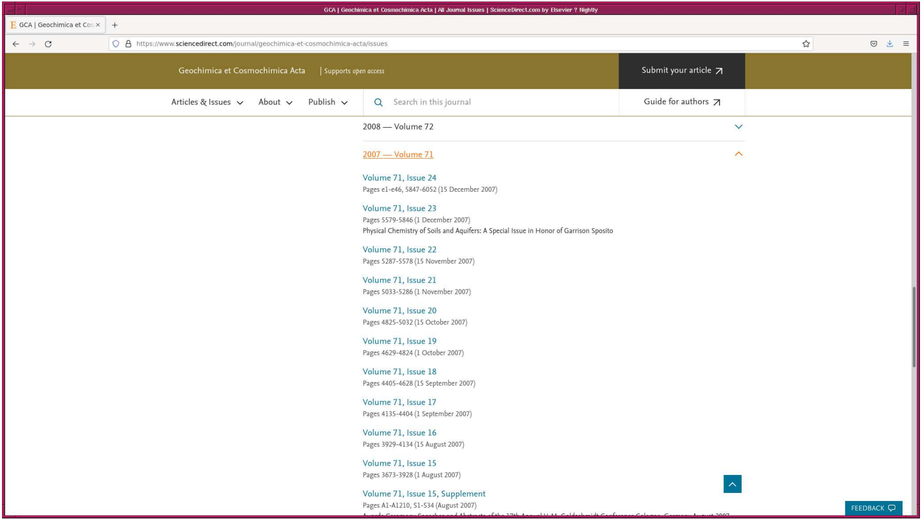

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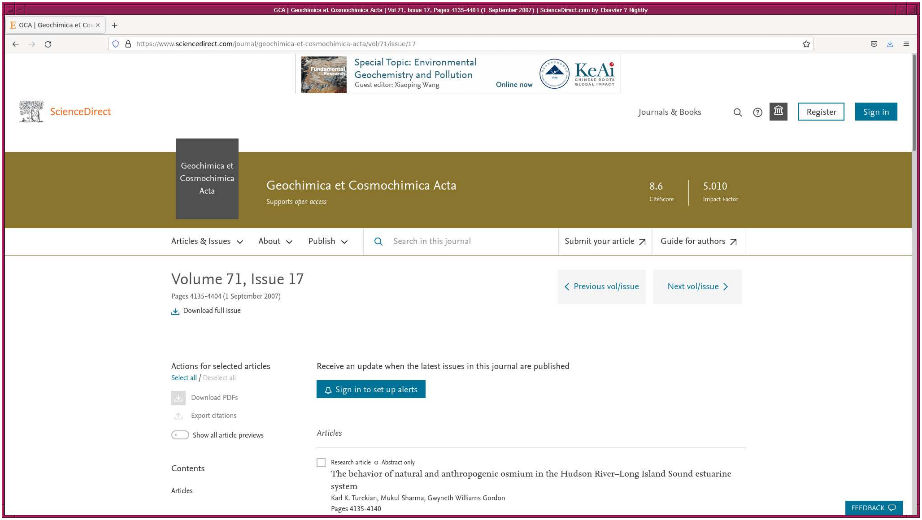

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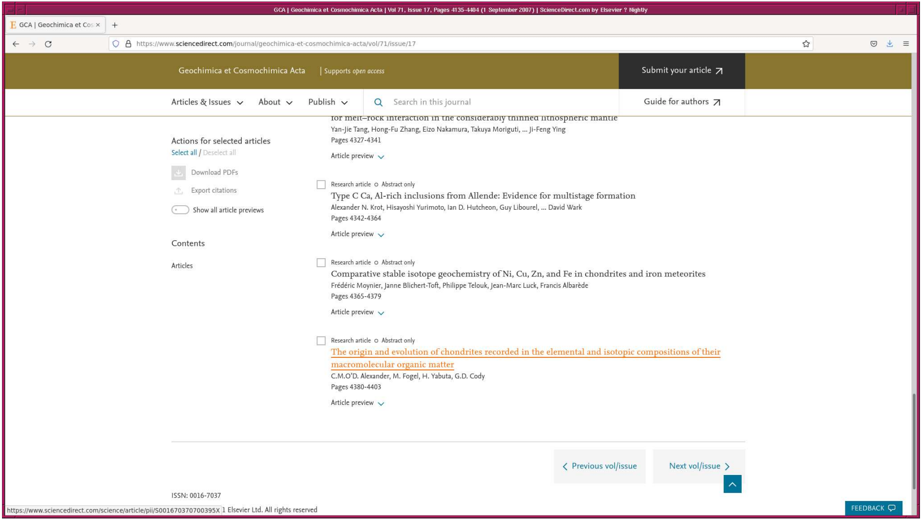

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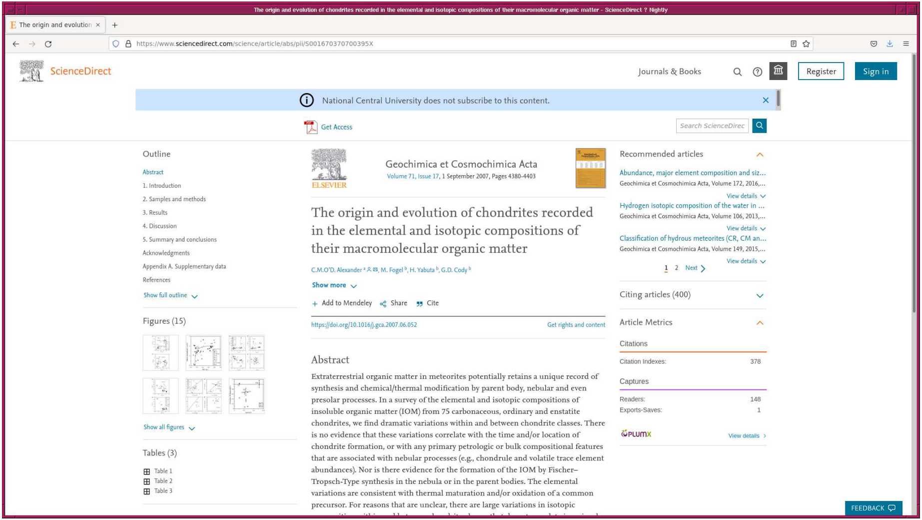

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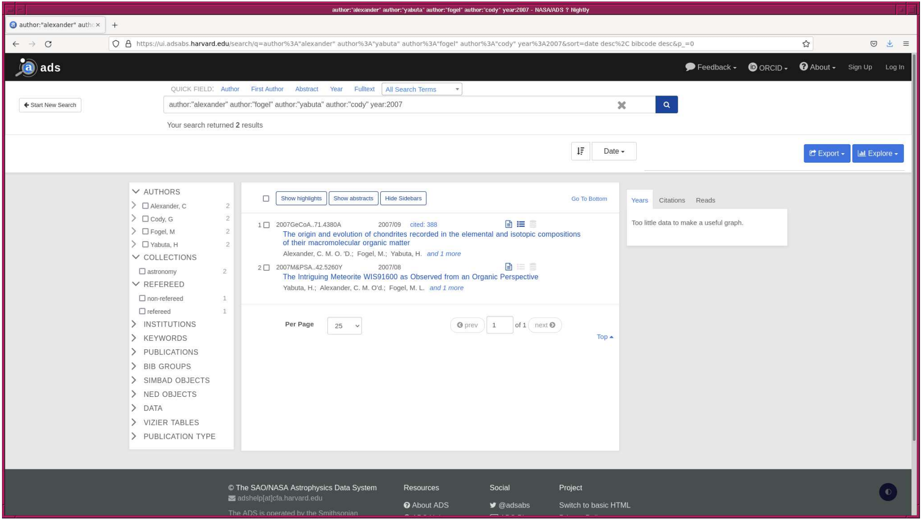

Appendix

Appendix A: Supplementary material

A.1. Additional information on the data set

We used OVIRS spectra from the Recon A phase of the OSIRIS-REx mission, specifically those that were collected on four separate dates in October 2019 (Reuter et al. 2019). These observations covered the mission's primary sample collection site, Nightingale, and three other candidate sample sites (Lauretta et al. 2021), as well as a few other areas of interest that were observed by opportunity. The spacecraft scanned the surface from a 1 km range with varying phase angles; the scan patterns are shown in Fig. A.1. OVIRS data collected during Recon A have a spatial resolution of 4 to 5 m cross-track and 7 to 10 m along-track (36 m^2).

A.2. Methods: Calibration and data processing

Full details of the calibration pipeline are described in Simon et al. (2018). Briefly, each OVIRS spectrum comprises five segments collected from separate linear variable filters, with overlapping wavelengths that are resampled to create a continuous spectrum from 0.39 to 4.3 µm (Reuter et al. 2018). A thermal tail is subtracted from calibrated radiance (resampled) spectra, and the result is divided by solar flux to obtain reflectance (I/F; Simon et al. 2020a). Thermal fill-in can occur for the sake of direct comparison (Tables A.2 and A.3). These spectra are all previously published, and references can be found in the main text. To compare spectral shape rather than feature strength, we normalized each continuum-removed spectrum to have a maximum value of 1 and a minimum value of 0 (Fig. 2). All analyses were performed on unsmoothed spacecraft data and reflect the noise inherent in spacecraft data; Figs. 1 and 2 also show spectra smoothed to demonstrate the likely underlying shape.

We used two previously tested methods to separate organic (CH) absorptions near 3.4 µm from the carbonate (CO_3) absorptions that are found at similar wavelengths to obtain the organic-rich group of spectra (Kaplan et al. 2020; Ferrone et al. 2021); both methods resulted in similar rates of organic and carbonate identification for the Recon A data set (Ferrone et al. 2021). The first method is linear least-squares fitting, in which we compared (unsmoothed) OVIRS spectra and laboratory spectra (at their native S/N but resampled to OVIRS spectral resolution) on a channel-by-channel basis from 2.9 to 3.6 µm to find the laboratory spectrum that best fits the shape of the organic features observed in our Recon A data set. We assessed the goodness of fit with a χ^2 statistic (Kaplan et al. 2020, Fig. A.4). Recon A spectra that were fit by one of the organic laboratory spectra with a χ^2 value < 2 were designated as organic-rich for this study, which resulted in 237 used for further analyses (e.g., in Fig. 3). The full

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  - authors' names
  - affiliations and addresses
  - abstract
  - keywords
- main body
  - introduction
  - observations or calculations or mathematical derivations
  - results
  - discussion
  - conclusions
- last part
  - acknowledgements
  - references
  - appendix

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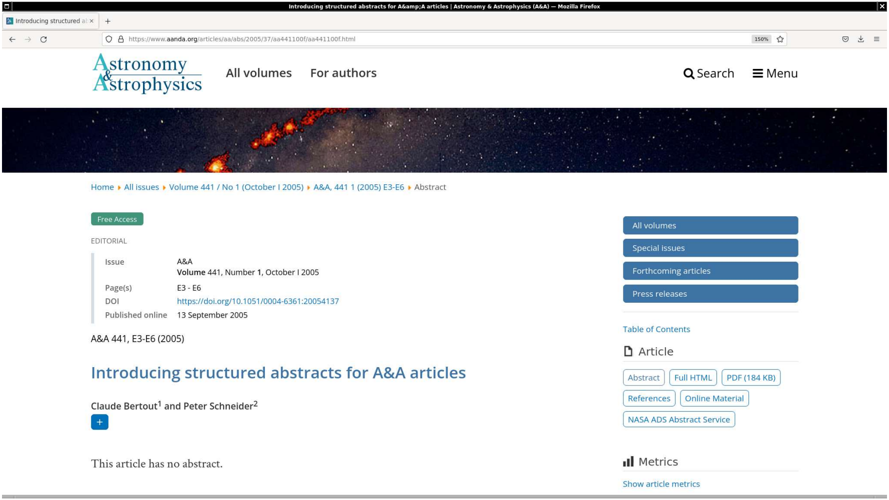
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EDITORIAL

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Introducing structured abstracts for A&A articles

Claude Bertout[1] and Peter Schneider[2]

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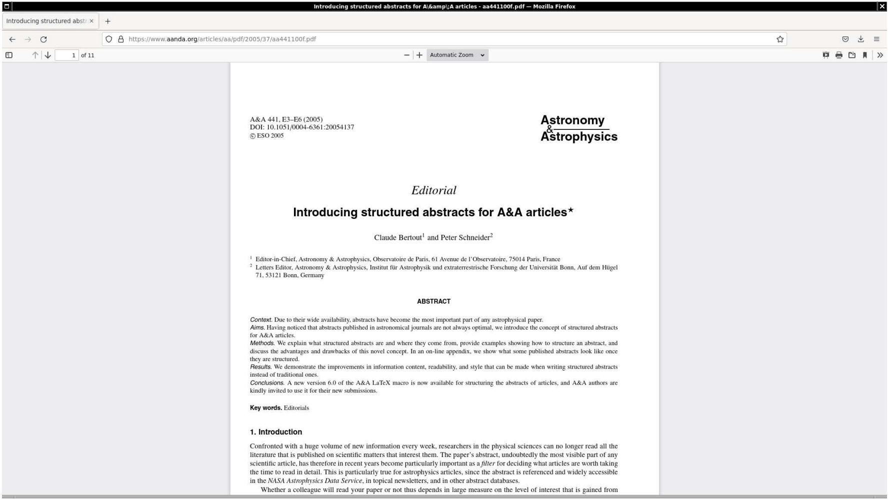

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Astronomy & Astrophysics

Editorial

Introducing structured abstracts for A&A articles*

Claude Bertout[1] and Peter Schneider[2]

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ABSTRACT

Context. Due to their wide availability, abstracts have become the most important part of any astrophysical paper.
Aims. Having noticed that abstracts published in astronomical journals are not always optimal, we introduce the concept of structured abstracts for A&A articles.
Methods. We explain what structured abstracts are and where they come from, provide examples showing how to structure an abstract, and discuss the advantages and drawbacks of this novel concept. In an on-line appendix, we show what some published abstracts look like once they are structured.
Results. We demonstrate the improvements in information content, readability, and style that can be made when writing structured abstracts instead of traditional ones.
Conclusions. A new version 6.0 of the A&A LaTeX macro is now available for structuring the abstracts of articles, and A&A authors are kindly invited to use it for their new submissions.

Key words. Editorials

1. Introduction

Confronted with a huge volume of new information every week, researchers in the physical sciences can no longer read all the literature that is published on scientific matters that interest them. The paper's abstract, undoubtedly the most visible part of any scientific article, has therefore in recent years become particularly important as a *filter* for deciding what articles are worth taking the time to read in detail. This is particularly true for astrophysics articles, since the abstract is referenced and widely accessible in the *NASA Astrophysics Data Service*, in topical newsletters, and in other abstract databases.

Whether a colleague will read your paper or not thus depends in large measure on the level of interest that is gained from

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Introduction (1)

Confronted with a huge volume of new information every week, researchers in the physical sciences can no longer read all the literature that is published on scientific matters that interest them. The paper's abstract, undoubtedly the most visible part of any scientific article, has therefore in recent years become particularly important as a filter for deciding what articles are worth taking the time to read in detail. This is particularly true for astrophysics articles, since the abstract is referenced and widely accessible in the NASA Astrophysics Data Service, in topical newsletters, and in other abstract databases.

Introduction (2)

Whether a colleague will read your paper or not thus depends in large measure on the level of interest that is gained from reading your paper's abstract. When writing it, one must therefore make sure that it conveys the essential elements of the article to the reader: its objective, the methods used to reach it, and the results obtained. This must be done in a concise yet informative way, without using external references that will not be referenced in the abstract databases. Finally, the style must be pleasing.

Introduction (3)

While editing A&A articles, we have become aware that the abstracts of published papers have not always fulfilled the criteria given above. Sometimes an abstract will be so concise and specialized that only the few people working in the paper's specific research field are able to understand the significance of results obtained by the author. At other times, the abstract goes into unnecessary detail and becomes much too unwieldy. We have also seen cases where the abstract does not reflect the paper's contents, either because some important results are not mentioned or because results presented in the abstract are not substantiated in the text of the paper. Of course, these extreme cases remain relatively rare, but we nonetheless concluded from studying a large number of A&A abstracts that in most cases, they could be written in a clearer and more informative way.

Introduction (4)

This is why we are introducing the concept of structured abstracts for A&A papers. The following will hopefully be able to convince you that the information content, readability, and style of your abstracts will be vastly improved by adopting the simple rules of structured abstracts, thereby increasing the impact of your articles.

What are structured abstracts? (1)

As with a traditional abstract, a structured abstract summarizes the contents of the paper, but it also makes the structure of the article explicit and visible. To accomplish this, the structured abstract uses headings that define each of several short paragraphs and that reflect the particular needs of the discipline. For astronomy papers, we propose to use three mandatory paragraphs as the core of the structured abstract, entitled, respectively, Aims, Methods, and Results. When appropriate, the structured abstract may use an introductory paragraph entitled Context, and a final paragraph entitled Conclusions. While these headings are self-explanatory, one should emphasize that there is no redundancy between them. For example, the Aims paragraph describes the objectives of the paper, while Context explains the reasons for the current investigation and may give background. Similarly, Results summarizes the results found in the paper, while Conclusions explains the significance of the results in a more general framework.

What are structured abstracts? (2)

Although structured abstracts are now mandatory in most medical research journals and are also successfully used in the social sciences, they have so far attracted little attention in the physical sciences. We note, however, that the astronomical community already uses structured documents, such as the well-known ESO Observing Proposal. Many other observing and grant proposal formats make use of structured contents, so the principle is not new to astronomers.

Structured abstract

- Context
    - reasons for the current investigation
    - background
- Aims
    - objectives
- Methods
- Results
- Conclusions
    - significance of the results

Today's Exercise #2

- Go to Astrophysical Journal website.
  - `https://iopscience.iop.org/journal/0004-637X`
- Visit the Volume 936 of ApJ.
  - `https://iopscience.iop.org/volume/0004-637X/936`
- Visit the Issue Number 1 (1 September 2022).
  - `https://iopscience.iop.org/issue/0004-637X/936/1`
- Pick a paper.
- Read the abstract of the paper you have picked.
- Analyse the abstract.
  - What is the context of the paper?
  - What is the aims of the paper?
  - What is the methods of the paper?
  - What is the results of the paper?
  - What is the conclusions of the paper?
- Tell us the results of your analysis.
- Tell me if you have any difficulty for doing this exercise.
- When finished, tell me so.

Today's Exercises #1 and #2

- Visit the Google Forms and submit the material.
  - Make a single PDF file and write down your answers for both Exercise #1 and #2.
  - Submit your results by 10:00 on 28/Sep/2022.
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