The dark Universe is not invisible

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and collaborators (next slide)

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Further reading:

• Zioutas, K.; Tsagri, M.; Semertzidis, Y.K.; Hoffmann, D.H.H.; Papaevangelou, T.; Anastassopoulos, V. The 11 years solar cycle as the manifestation of the dark Universe, Mod. Phys. Lett. 2014, A29(#37) 1440008, https://arxiv.org/abs/1309.4021.

• Bertolucci, S.; Zioutas, K.; Hofmann, S.; Maroudas, M. The sun and its planets as detectors for invisible matter, Phys. Dark Univ. 2017, 17 13-21, and ref’s therein; https://doi.org/10.1016/j.dark.2017.06.001.

• Zioutas, K.; Argiriou, A.; Fischer, H.; Hofmann, S.; Maroudas, M.; Pappa, A.; Semertzidis, Y.K. Stratospheric temperature anomalies as imprints from the dark universe, Phys. Dark Univ. 2020, 28, 100497; https://doi.org/10.1016/j.dark.2020.100497.

• Patla, B.R.; Nemiroff R.J.; Hoffmann, D.H.H.; Zioutas, K. Flux Enhancement of Slow-moving Particles by Sun or Jupiter: Can they be detected on Earth?, ApJ. 2014, 780(#2) 158; https://arxiv.org/abs/1305.2454.

• Sofue, Y. Gravitational Focusing of Low-Velocity Dark Matter on the Earth's Surface, Galaxies 2020, 8(#2) 42, https://doi.org/10.3390/galaxies8020042; https://arxiv.org/abs/2005.08252.

• Helmi, A.; Babusiaux, C.; Koppelman, H.H.; Massari, D.; Veljanoski, J.; Brown, A.G.A. The merger that led to the formation of the Milky Way’s inner stellar halo and thick disk Nature 2018, 563, 85–88, https://doi.org/10.1038/s41586-018-0625-x.

• More details are given in talks given: 2016 at CERN https://indico.cern.ch/event/520074/ & 2018 in ECT / Trento https://indico.ectstar.eu/event/25.
**Abstract:** Dark matter (DM) came from long-range gravitational observations which actually does not interact with ordinary matter. Though, on much smaller scales, a number of unexpected phenomena contradict this picture for DM. Because, some of the solar activity or the dynamic earth’s atmosphere might arise from DM streams. Gravitational (self-)focusing effects by the Sun or its planets of streaming DM fits as the underlying process, e.g., for the otherwise puzzling 11-year solar cycle, the mysterious heating of the solar corona with its fast temperature inversion, etc. Observationally driven we arrive to an external impact by as yet overlooked “streaming invisible matter”, which reconciles some of the investigated mysterious observations. Unexpected planetary relationships exist for the dynamic Sun and Earth atmosphere and are considered as the signature for streaming DM. Then, focusing of DM streams could also occur in exoplanetary systems, suggesting for the first time investigations by searching for the associated stellar activity as a function of the exoplanetary orbital phases. The entire observationally driven reasoning is suggestive for highly cross-disciplinary approaches including also (puzzling) bio-medical phenomena. Favorite candidates from the dark sector are the highly ionizing anti-quark nuggets, magnetic monopoles, but also particles like dark photons.
Our universe is dominated by a mysterious matter known as DM. Its name comes from the fact that DM does not absorb, reflect or emit electromagnetic radiation, making it difficult to detect.

Counter examples => this work
Our working hypotheses:

- Planetary (and solar) gravitational focusing of non-relativistic “invisible massive particles”
- The focused invisible streaming matter interacts “strongly” with solar / planetary atmospheres >> no screening, ...
- Repeating activity enhancement during planetary alignment

Search for planetary relationship

Project timing => $\Theta_{\text{longitude}}$

origin
Cartoon illustration of gravitational (self-)focusing effects of DM streams

Gravitational lensing

\[ \Theta_{\text{deflection}} \sim \frac{1}{v^2} \]

18th December
Galactic Centre

2 peaks \(~180^\circ\) apart!

[Adrien Leleu]

\[ \sigma_{\text{trap}} = \pi R^2 \left( 1 + \frac{v^2}{v_{\text{esc}}^2} \right) \]

SUN: \( v_{\text{esc}} = 612 \text{ km/s} \)
Within known physics

Dark sector signatures are not expected

Unexpected Solar / terrestrial behavior

Are insisting anomalies/mysteries in the solar system the unnoticed manifestation of the dark Universe ➔ Yes (this work).

How? Why? >> not ALL!
ZWICKY, 1933: DM from unexpected cosmic scale obs’s.

WOLF, 1859: “first” to suspect planetary involvement @ Sun

>> HOW?

Inbetween:

1. Several small scale unexpected observations.
2. WOLF ZWICKY
3. clear planetary relationship

⇒ streaming DM

The key feature + driving idea for this work

⇒⇒ what else?
The 11-year solar cycle

9.93 yr = P_{JupSat} ≈ 10.02 yr

11.01 yr \sim P_{VeEaJup} = 11.07 yr

11.8 yr \Rightarrow P_{Jupiter}

11 yrs \approx 11.86 yrs

Solar cycle \approx P_{JUPITER}

Planetary dependence
Suspected since 1859

Remote Force?
The Q ever since!

https://arxiv.org/abs/1309.4021
The theory of a planetary modulation of solar activity

Extract of a Letter from Prof. R. Wolf, of Zurich, to Mr. Carrington, dated Jan. 12, 1859.
(Translation.)

400 Years of Sunspot Observations

The ~11-year sunspot cycle

Overlooked!
Too weak within known physics
therefore abandoned!

the same planets, the conclusion seems to be inevitable, that my conjecture that the variations of spot-frequency depend on the influences of Venus, Earth, Jupiter, and Saturn, will not prove to be wholly unfounded. The preponderating planet

http://people.duke.edu/~ns2002/pdf/Scafetta_AGU-2012.pdf
Scafetta, N.: 2012a, J. Atmos. Sol. Terr. Phys., 80, 296

https://slideplayer.gr/slide/7988163/
The key signature:

Planetary relationships of solar system observables

- remote planetary forces unknown, except:

  => gravitational tidal forces:
  - Smooth change $\sim 1/R^3$ do not fit obs’s
  - too feeble: missing factor $\leq 10^{-11}$
  - Peaking dependence excludes a remote planetary interaction

DOI: 10.1023/A:1022912430585 Sol. Phys. (2003)
Discarded…

because inconsistent w’ $1/R^3$ tidal force

http://adsabs.harvard.edu/abs/1967AJ....72..463B AJ (1967)

http://dx.doi.org/10.1016/j.dark.2017.06.001
Phys.Dark Univ. (2017)

**MERCURY**

![Graph showing departures from mean sunspot numbers as a function of Mercury's position. Equivalent to the mean waveform of the detected signal.](image)

"It is immediately obvious that no simple theory will entirely account for this complex pattern, but one of the maxima occurs near Mercury’s closest approach to the sun and the two conspicuous minima occur quite close to the planet’s greatest departures from the plane of the earth’s orbit (N and S in Fig.)."

**Planetary dependence**

![Graph showing solar EUV >24 eV and sum of 64x88 days.](image)

The manifestation of the hot corona

11
Discarded... 1967

because inconsistent w’ 1/R^3 tidal force

MERCURY

2017 Planetary dependence

http://adsabs.harvard.edu/abs/1967AJ.....72..463B AJ (1967)

http://dx.doi.org/10.1016/j.dark.2017.06.001

Phys. Dark Univ. (2017)

It is immediately obvious that no simple theory will entirely account for this complex pattern, but one of the maxima occurs near Mercury’s closest approach to the sun and the two conspicuous minima occur quite close to the planet’s greatest departures from the plane of the earth’s orbit (N and S in Fig.).

Fig. 4. Departures from mean sunspot numbers as a function of Mercury’s position. Equivalent to the mean waveform of the detected signal.

The manifestation of the hot corona

Solar EUV >24 eV
SUM of 64x88 days

16/2/1999
So far:
Various solar / terrestrial obs’s show planetary relationship. see below

Rule of thumb:
An obs’ with 11yrs rhythm implies planetary dependence

Note:
*a planetary relationship can show-up only if the underlying cause within the solar system is (partly) in form of streams.*
More...

...planetary relationships within the solar system

+ in exoplanetary systems?
Solar Flares

1859 - unpredictable mysteries
one of the most important challenges in solar physics [1]

Solar Corona

1939 - one of the fundamental problems
in space science [2].

Ionosphere

1937 - a long-standing unexplained annual anomaly [3]:

\[ \rho_e(\text{DEC}) > \rho_e(\text{JUNE}) \]

Sunspots + MBPs + solar elemental composition + 2.8 GHz + ...

[1] V. Polito et al., ApJ 816 (2016) 89; https://doi.org/10.3847/0004-637X/816/2/89
[2] J.A. Klimchuk et al., PASJ (2017); https://arxiv.org/abs/1709.07320
[3] E.V. Appleton, Proc. Roy. Soc. London A162 (1937) 451; http://rspa.royalsocietypublishing.org/content/162/911/451 .

Unanswered puzzles within known physics!
Solar Flares

peaking & planetary relationships!

&) exclude a remote planetary interaction, e.g., tidal forces

Data from M.J. Aschwanden
M-class solar flares

- **EXCESS/RANDOM** >45%
  - dominating planetary impact
- **3 NARROW PEAKS** =/=> tidal forces

http://cerncourier.com/cws/article/cern/69886
Sunspots 1900-2016 >> MARS-EARTH synod = 780 days => substructure!

Combined planetary relationship

Simplest FOURIER analysis with time resolution.

Sunspots 1900-2016

\[ \sum \text{Nr. of Sunspots/15 days} \]

780 days

\[ <\sigma_{\text{BIN}} > \approx 0.38\% \]

7.6σ

54 x 780 days

MARS-EARTH synod = 780 days

Combined planetary relationship

Simplest FOURIER analysis with time resolution.

Synod

18%
The measured atmospheric total electron content in TECUs, 1 TECU = $10^{16} \text{ e/m}^2$ as a function of the Earth’s heliocentric longitude averaged over 1 day (1995–2012).

PDU (2017)  [http://dx.doi.org/10.1016/j.dark.2017.06.001](http://dx.doi.org/10.1016/j.dark.2017.06.001)

$\Delta$TECU: the difference between the winter–summer solstices (s. Fig. on the right) = $f$(Moon Phase), while the Earth is in one of the two 30° orbital segments (green bars on the left Fig.)

PDU (2017)  [http://dx.doi.org/10.1016/j.dark.2017.06.001](http://dx.doi.org/10.1016/j.dark.2017.06.001)

→ Moon as gravitational lens? >> YES =>
Moon → Earth focusing: \( \leq 400 \text{ km/s} \)

amplification \( \approx 10^4 \times \)

Earth intrinsic self-focusing: max @ 17 km/s (\( 10^9 \times \))

[Sofue] 2020 [https://arxiv.org/abs/2005.08252](https://arxiv.org/abs/2005.08252)

[.Kryemadhi,M. Vogelsberger, K.Z. in prepar.(2021)]

→ Overlooked in DM research ←
Stratosphere: temperature anomalies as imprints from the dark Universe

Fig. 1. (Top) Time dependence of the mean daily stratospheric temperature \([09:00+12:00/2]\) at 3, 2, 1 hPa (altitude \(\approx 38.5, 42.5, 47.5\) km), 42.5\(^\circ\)/13.5\(^\circ\) for the period 1986-2018. The period analysed in this work is indicated and is also shown expanded (Bottom). The vertical dashed lines are year boundaries. 1st January 2008 ... 2017. The error bar of each point is equal to 0.5 K [19].

Fig. 8. A comparison between the mean temperature spectra of the upper stratosphere (top) and the lower stratosphere (bottom). The lower stratosphere (16–31 km) is the main ozone layer, which is strongly affected by the solar UV. The striking difference between both spectra implies that the upper stratosphere (38.5–47.5 km) is marginally or even not affected at all by the solar UV. The position of the Galactic Center in this plot is at \(\approx 86.5^\circ\), and the upper stratosphere reaches its maximum temperature \(\approx 16\) days later.

https://doi.org/10.1016/j.dark.2020.100497
“Solar composition problem”

The mystery of the sun’s missing matter

“perhaps we are looking at the sun in the wrong way”

S. Palus, NEW SCIENTIST (18th Oct. 2017) https://www.newscientist.com/issue/3148/
Elemental Composition ➔ Magnetic Bright points ➔

Planetary relations: how to reconcile w. conventional picture?

(a) https://www.nature.com/articles/s41467-017-00328-7 NATURE Comm. 2017
(b) https://arxiv.org/abs/1710.01678 PASJ 2017

M. Maroudas and D. Utz, work in preparation 2021
F10.7cm = 2.8 GHz solar line
→ SOLAR PROXY ←

Solar spectrum: $\lambda => 5-30$ cm

$\lambda = 10.7$ cm

===== LONGITUDE MERCURY [°] ===== >

VENUS 200°-320°
MERCURY
07/12/1963 - 22/08/2017

10%
Focusing of DM streams could also occur there, experiencing streaming DM the same way as with our solar system. Planetary focusing in those systems could be initially investigated by searching for the associated stellar activity as a function of the exoplanetary orbital phases (~Longitude).
1 example ...

... outside physics ➔
Planetary Dependence of Melanoma

USA <monthly> data 1973-2011

AUSTRALIA daily data 1982-2015

..a 27 Days Periodicity in Melanoma Diagnosis

87.97 days

Confirmed independently

http://dx.doi.org/10.1142/S179304801850008X

http://dx.doi.org/10.1142/S1793048020500083

@Mercury’s orbit

@Moon’s orbit

27.32 days (sidereal)

⇒ fixed to remote stars

Origin: exo-solar!
AntiQuark Nuggets (AQNs):

dark matter + missing antimatter + (much) more?

N. Raza, L. van Waerbeke, A. Zhitnitsky, Solar Corona Heating by the AQN Dark Matter, arXiv:1805.01897 (2018), Phys. Rev. D 98 (2018)103527

Candidates:

1. AQNs
2. Magnetic monopoles
3. Dark photons

Or, a combination from + more.
Conclusions

✓ Various solar obs’s fit planetary gravitational focusing of stream(s) of invisible massive particles ☝️ puzzling solar/terrestrial behaviour:
Hot Corona, Flares, Elemental composition, MBPs, sunspots, ...?...

✓ Similar searches with the dynamic ionosphere (combining with other data underneath).

✓ Nature of the invisible particles not identified yet. Possible candidates:
AQNs, Magnetic monopoles, Dark photons ➔ *inspiring new search strategies*.

✓ Underground DM exp’s, search for new planetary relationships
  ➔ *Any ~11yrs relationship suggestive for re-analysis*

✓ DM searches may profit from temporal signal enhancement up to $10^{11}$ ➔ no screening?

✓ Tidal effects on the solar surface are excluded ($\approx 10^{-12}\cdot \text{SUN Gravity}$)
  ➔ the planetary working hypothesis: the only viable scheme.

✓ More TBD? e.g. various solar / terrestrial obs’s ➔ *exosolar planetary systems (!?)*,
  plus Biomedicine ➔ *first results with melanoma rates encouraging*

✓ **Ultimate goal:** decipher the properties of the streaming DM particles.

✓ **novel approaches in ongoing DM searches:** design and/or re-analysis
The Dark World is not dark!

THANK YOU
The Dark Universe: The Harbinger of a Major Discovery

Guest Editor
Prof. Konstantin Zioutas

Deadline
31 August 2021

mdpi.com/si/69375
Additional slides
Planetary Dependence of Melanoma

http://dx.doi.org/10.1142/S179304801850008X

USA <monthly> data 1973-2011

Adding up consecutive $5 \times 88 \text{ d} \Rightarrow 440\text{days}$:

..a 27 Days Periodicity in Melanoma Diagnosis

https://doi.org/10.1142/S1793048020500083

AUSTRALIA daily data 1982-2015
Full disk:

**Solar EUV**

- **Analysis code #1**

- **Analysis code #2**
Chromosphere ↔ Corona

AQNs: 
- the only solar atmospheric model explaining the ~100 km thin Transition Region
- planetary dependence of the flaring Sun
- more? >>> unexplained obs’?!
"Solar Cycle Variations of Rotation + Asphericity in the Near-Surface Shear Layer"

Figure 3: a) The sunspot number, SN, averaged for the 72-day periods corresponding to the intervals of the helioseismic analysis. b) Variations of the seismic radius proxy (Eq. 3) relative to the first measurement in 1996, as deduced from the analysis of the f-modes extracted from the MDI and HMI data from 1996 to 2017. The relative amplitude modulation of about $-2.3 \times 10^{-5}$ in Solar Cycle 23 and about $-1.7 \times 10^{-5}$ in Cycle 24 is clearly in anti-phase with the solar activity. The error bars show three standard deviations calculated using observational error estimates of the mean f-mode frequencies.

A. Kosovichev, J-P. Rozelot, J. Atm. Solar-Terr. Phys., 176 (2018) 21, https://doi.org/10.1016/j.jastp.2017.08.004 ; https://arxiv.org/abs/1804.05081

https://spaceweatherarchive.com/2018/09/27/the-chill-of-solar-minimum/ Sept. 2018
Σ Nr. of Sunspots/22 days

66× 643 days

14%
VENUS 200° - 320°
07/12/1963 - 22/08/2017

10% Min <-> Max Value

VENUS 200° - 320°
07/12/1963 - 22/08/2017

MERcer: 360

RUN

INTEGRAL: Mars class: 807038.2
INTEGRAL: M class: 6572
CLASS: Mars class: 122.7995
Stream from Galactic Centre mega-BlackHole?

Heliocentric longitude ≈ 266° + TOF (Earth ⇒ Sun) ➔ 18th December
UNIVERSE

~$10^5$ years

ΔT/T ~ $10^{-5}$

SUN

~$10^9$ years

ΔT/T ~ $10^{+3}$
Gravitational (self)-focusing

Gravit. focusing: Sun + planets

\[ \Delta \Phi = \frac{4MG}{bc^2} \]
\( b = \) impact factor
\( \mathbf{C} = \) velocity

Gravit. (self)-focusing

\[ \sigma_{\text{trap}} = \pi R^2 \left( 1 + \frac{v_{\text{esc}}^2}{v_{\text{rel}}^2} \right) \]

SUN: \( v_{\text{esc}} = 612 \text{ km/s} \)

In collaboration with Adrien Leleu / Bern:

2 peaks ~180° apart!

https://iopscience.iop.org/article/10.1088/1475-7516/2019/06/014/pdf
Evidence for a New Component of HE Solar γ-Ray Production

The observed multi-GeV γ-ray emission from the solar disk—sourced by hadronic cosmic rays interacting with gas and affected by complex magnetic fields—is not understood ... Most strikingly, although six γ rays above 100 GeV were observed during the 1.4 yr of solar minimum, none were observed during the next 7.8 yr. These features, along with a 30–50 GeV dip ... were not anticipated by theory.

To understand the underlying physics, Fermi-LAT +HAWC obs’s of the imminent ... solar Minimum are crucial.

Our work: >>> search for planetary dependence!

T. Linden, B Zhou, JF Beacom, AHG Peter, KCY Ng, Q-W Tang, Phys. Rev. Lett. 121 (25th Sept 2018) 131103
https://doi.org/10.1103/PhysRevLett.121.131103
Wolf, 1859: solar dynamics is partially driven by planetary tides. A plausible physical mechanism has not been discovered yet... the planetary tidal forces are too small to modulate solar activity. although more complex mechanisms can not be excluded.

N. Scafetta, J. Atm. & Sol.-Terr. Phys. 81–82(2012)27

Critical Analysis .. of the Planetary Tidal Influence on Solar Activity
We found ... artefacts caused by the calculation algorithm ...
We conclude: the considered hypothesis [A.&A. 548(2012) A88] is not based on a solid ground. S. Poluianov, I. Usoskin, Sol. Phys. 289 (2014) 2333
Solar Corona 1939- >>> observational mystery.

Sun's upper atmosphere much hotter than its surface =&gt; why?

• ”a major open issue in astrophysics” 2015
• ”one of the fundamental outstanding problems in solar physics” 2015
• “for 77 years...one of the outstanding unsolved problems in astrophysics” 2015

[http://arxiv.org/abs/1502.07401; http://arxiv.org/abs/1508.05354; DOI: 10.1098/rsta.2014.0269]

The striking EUV excess of the quiet Sun is the manifestation of the solar corona problem.

H.S. Hudson

http://dx.doi.org/doi:10.1007/BF01488890
Earth’s Atmosphere 1937

- peak electron density around December is greater than around June ≠ expectation a long-standing unexplained annual anomaly

- “the writers are inclined to the view that the cause is associated with the Earth or its motion…” 1938
  doi:10.1029/TE043i001p00015

- .. there is a global annual anomaly.
  J. Lean et al., J.G.R. 116 (2011) A10318, doi:10.1029/2011JA016567

| Year | Month | Total Electron Content |
|------|-------|------------------------|
| 1935 | Dec   | 2.87 \(10^{32}\) e\(^{-}\)s |
| 1936 | June  | 2.12 \(10^{32}\) e\(^{-}\)s |

Proc. Roy. Soc. London A162 (1937) 451

J. Atm. Sol.-Terr. Phys. 67 (2005) 1377
Stream(s) from G.C. mega-Black Hole?

Longitude $\approx 266^\circ$ + TOF (Earth $\Rightarrow$ Sun)  
$\Rightarrow$ 18th December

Longitude $\approx 85^\circ$ + TOF (Moon $\Rightarrow$ Earth)  
$\Rightarrow$ 17th June, ..??..
EARTH’s IONOSPHERE

Anomalies lasting for some decades

>>> First obs’ 1937/1938

Diagram showing the ionosphere with different layers and electron density.
MERCURY

VENUS

FLARES/EUV
EARTH

- M-Flares
  - Number of M-Flares per 6° longitude
  - Peaks at 45°, 90°, 135°, 177°, 265°, 285°, 325°

- X-Flares
  - Number of X-Flares per 12° longitude
  - Peaks at 258°, 294°, 42°
