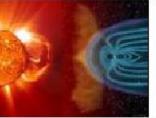
ASTR-3760 Solar & Space Physics

Axel Brandenburg (LASP & APS)

Images for Space physics









Laboratory for Atmospheric and Space Physics lasp.colorado.edu/ ▼

Conducts basic theoretical and experimental research in planetary, atmosphe magnetospheric, and solar **physics**.

Why is it exciting?

- It is magnetic!
- Can see physical processes in detail
 - -Relevance to galaxies, disks, cosmology
- Of direct concern to humans
 - -Aviation: radio blackouts, radiation load
 - -Geomagnetically induced currents
 - -Climate on Earth??

Current Conditions

Solar wind

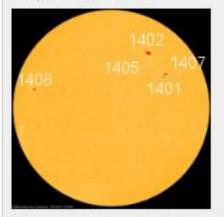
speed: 290.4 km/sec density: 3.0 protons/cm³

explanation | more data Updated: Today at 2344 UT

X-ray Solar Flares

6-hr max: **C1** 2011 UT Jan23 24-hr: **M8** 0359 UT Jan23 explanation | more data Updated: Today at: 2300 UT

Daily Sun: 23 Jan 12



Sunspots 1401 and 1402 pose a threat for M-class solar flares. Credit: SDO/HMI

Sunspot number: 103
What is the sunspot number?
Updated 22 Jan 2012

What's up in space

Monday, Jan. 23, 2012

Metallic photos of the sun by renowned photographer Greg Piepol bring together the best of art and science. Buy one or a whole set. They make a stellar gift.



RADIATION STORM IN PROGRESS: Solar protons accelerated by this morning's M9-class solar flare are streaming past Earth. On the NOAA scale of radiation storms, this one ranks <u>S3</u>, which means it could, e.g., cause isolated reboots of computers onboard Earth-orbiting satellites and interfere with polar radio communications. An example of satellite effects: The "snow" in this SOHO coronagraph movie is caused by protons hitting the observatory's onboard camera.

ALMOST-X FLARE AND CME (UPDATED): This morning, Jan. 23rd around 0359 UT, big sunspot 1402 erupted, producing a long-duration M9-class solar flare. The explosion's M9-ranking puts it on the threshold of being an X-flare, the most powerful kind. NASA's Solar Dynamics Observatory captured the flare's extreme ultraviolet flash:







Home News U.S. Sport TV&Showbiz Femail Health Science Money Right Science Home Pictures Gadgets Gifts and Toys Store

Biggest solar storm since 2003 pummels atmosphere, forcing planes to divert from northern routes

- Nasa says solar radiation storm is now biggest since 2003
- Storm can affect high-altitude communications systems and satellites
- Polar flights diverted

23 January 2012

Airlines including Delta have diverted flights across northern routes as the strongest solar storm since 2003 hits Earth's atmosphere.

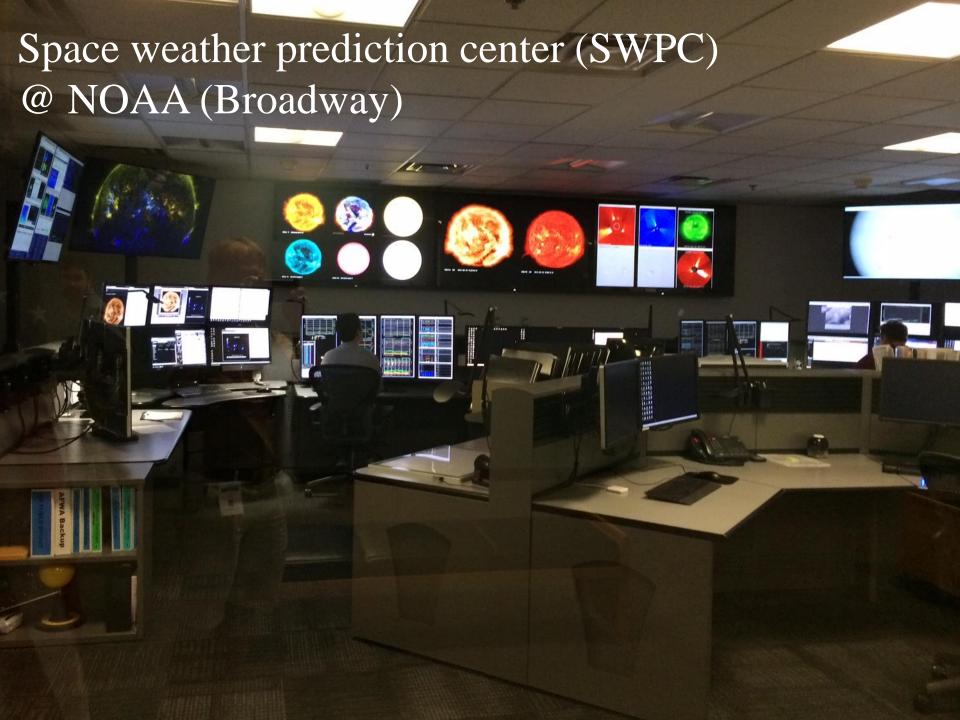
Airlines are avoiding North Pole routes, which the American National Oceanic and Atmospheric Administration says are more exposed to the proton storm caused by solar activity on January 23.

NOAA issued a warning for solar radiation storms, which can affect communications systems at high latitudes and satellite-based communications such as GPS. The crew on the International Space Station has not been harmed, but Nasa says problems with satellites are possible.



NASA handout images acquired 23 January 2012 and made available 25 January 2012 shows flare activity on the Sun. The images are from the Atmospheric Imaging Assembly on NASA's Solar Dynamics Observatory. The solar storms have the potential to disrupt satellite systems and communications

5



Historic space weather events

- 21 Dec 1806 Humbold: erratic compass var.
- 1 Sep 1859 Carrington flare: telegraphs disr.

Description of a Singular Appearance seen in the Sun on September 1, 1859. By R. C. Carrington, Esq.

While engaged in the forenoon of Thursday, Sept. 1, in taking my customary observation of the forms and positions of the solar spots, an appearance was witnessed which I believe to be exceedingly rare. The image of the sun's disk was,

Superflares on solar-type stars

Hiroyuki Maehara, Takuya Shibayama, Shota Notsu, Yuta Notsu, Takashi Nagao, Satoshi Kusaba, Satoshi Honda, Daisaku Nogami & Kazunari Shibata

Affiliations | Contributions | Corresponding author

Nature 485, 478-481 (24 May 2012) | doi:10.1038/nature11063 Received 13 October 2011 | Accepted 14 March 2012 | Published online 16 May 2012



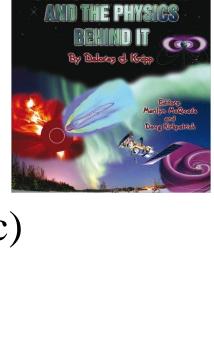
More recent weather events

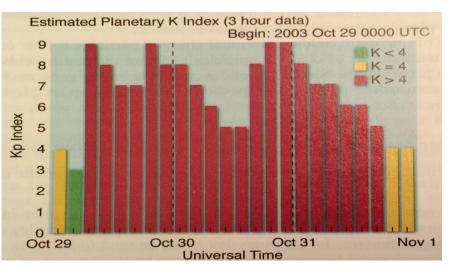
- 2 Aug 1972: life-threatening particle expos.
 - Apollo 16: 16 Apr 1972
 - Apollo 17: 7 Dec 1972
- 13 Mar 1989: Quebec blackout
- 30 Oct 2003: Halloween event, Kp=9 (!)
- Now routinely rerouting transpolar routes



Kp index

- Space Weather (SW), page 35
- Abnormal deflections of Earth's **B**-field
- From $0 \rightarrow 9$ (log scale, like m, dB, etc)
- Amount of flucts over 3h interval
- Kp > 7 unusual, Kp=9 for Halloween event
- K is for one station





Halloween event

SPACE WEATHER

Current Conditions



Solar Wind speed: 281.3 km/s

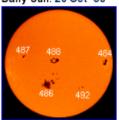
density: 48.7 protons/cm³ explanation | more data Updated: Today at 2256 UT

Note: Solar wind detectors onboard NASA's ACE spacecraft are currently saturated by the ongoing radiation storm. That is the (ironic) reason why solar wind values listed above are so low. Click here for better numbers from SOHO.

X-ray Solar Flares

6-hr max: M2 1615 UT 00128 24-hr: X17 1110 UT 00128 explanation (more data Updated: Today at 2140 UT

Daily Sun: 28 Oct '03



Sunspots 484 and 486 pose a continued threat for strong X-class solar flares. Image credit: SOHO MDI

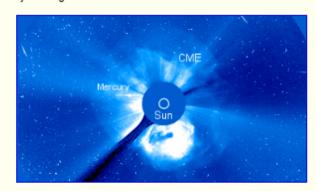
What's Up in Space -- 28 Oct 2003

Subscribe to Space Weather News!

Would you like a phone call when auroras appear over your home town? Sign up for Spaceweather PHONE.



EXTREME SOLAR ACTIVITY: One of the <u>most powerful</u> solar flares in years erupted from giant sunspot 486 this morning at approximately 1110 UT. The blast measured X17 on the <u>Richter scale of solar flares</u>. As a result of the explosion, a strong <u>S3-class</u> solar radiation storm is underway. <u>Click here</u> to learn how such storms can affect our planet. The explosion also hurled a coronal mass ejection (CME) toward Earth. When it left the sun, the cloud was traveling 2125 km/s (almost 5 million mph). This CME could trigger bright <u>auroras</u> when it sweeps past our planet perhaps as early as tonight.



Above: This SOHO coronagraph image captured at 12:18 UT shows the coronal mass ejection of Oct. 28th billowing directly toward Earth. Such clouds are called halo CMEs. The many speckles are solar protons striking the coronagraph's CCD camera. See the complete movie.

Current Conditions

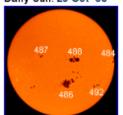


Solar Wind speed: 698.2 km/s density: 0.0 protons/cm³ explanation | more data Updated: Today at 2128 UT

Note: Solar wind detectors onboard NASA's ACE spacecraft are currently saturated by the ongoing radiation storm. That is the (ironic) reason why solar wind values listed above are so low. Click here for better numbers from SOHO.

X-ray Solar Flares
6-hr max: C8 1420 UT Oct29
24-hr: X11 2049 UT Oct29
explanation | more data
Updated: Today at 1615 UT

Daily Sun: 29 Oct '03



Sunspots 484, 486 and 488 pose a continued threat for strong X-class solar flares. Image credit: SOHO MDI

What's Up in Space -- 29 Oct 2003

Subscribe to Space Weather News!

STORM IN PROGRESS: An extreme geomagnetic storm is in progress. Sky watchers at all latitudes should be alert for auroras after nightfall. Meanwhile, another powerful solar flare (X11-class) has erupted from giant sunspot 486. Stay tuned for details

Would you like a phone call when auroras appear over your home town? Sign up for Spaceweather PHONE.

BRIGHT AURORAS: A coronal mass ejection swept past Earth today (at approximately 0630 UT on Oct. 29th) and triggered an intense geomagnetic storm. In the United States, Northern Lights (gallery) appeared as far south as Georgia, California, New Mexico, Arizona, Texas, and Oklahoma.

Right: Not far from Houston, Texas, photographer Christie Ponder snapped this picture of red auroras. "What a wonderful show! Vivid spikes shot up about 15 to 20 degrees above the horizon," she says.



The prospects for more auroras tonight are good, mainly because the interplanetary

magnetic field (IMF) near Earth has tilted sharply south--a condition that promotes geomagnetic activity. Indeed, an extreme geomagnetic storm is in progress. Sky watchers at all latitudes should be alert for auroras after local nightfall.

EXTREME SOLAR ACTIVITY: One of the <u>most powerful</u> solar flares in years erupted from giant sunspot 486 on Oct. 28th. The blast measured X17 on the <u>Richter scale of solar flares</u>. As a result of the explosion, a strong <u>S3-class</u> solar radiation storm is underway. <u>Click here</u> to learn how such storms can affect our planet. The explosion also hurled a coronal mass ejection (CME)

October 30 and 31, 2003

Current Conditions



Solar Wind speed: 282.7 km/s density: 0.8 protons/cm³ explanation | more data Updated: Today at 2232 UT

Note: Solar wind detectors onboard NASA's ACE spacecraft are currently saturated by the ongoing radiation storm. That is the (ironic) reason why solar wind values listed above are so low. Click here for better numbers from SOHO.

X-ray Solar Flares 6-hr max: M1 1525 UT Oct30 24-hr: X10 2049 UT Oct30

explanation | more data Updated: Today at 1955 UT

Daily Sun: 30 Oct '03



Sunspots 486 and 488 pose a continued threat for strong X-class solar flares. Image credit: SOHO

Sunspot Number: 330

What's Up in Space -- 30 Oct 2003

Subscribe to Space Weather News!

Would you like a phone call when auroras appear over your home town? Sign up for Spaceweather PHONE.



STORM IN PROGRESS: A severe geomagnetic storm is in progress on Oct. 30th. It began at approximately 1700 UT when a coronal mass ejection (CME) swept past Earth. The CME (movie) was hurled toward our planet yesterday by an X10-class explosion from giant sunspot 486. Sky watchers at all latitudes should be alert for auroras.

BRIGHT AURORAS: Oct. 29th was a great day for sky watchers. A CME hit Earth's magnetic field and triggered an extreme geomagnetic storm. In the United States, Northern Lights appeared as far south as Florida, New Mexico, Arizona and Texas.



Current Conditions



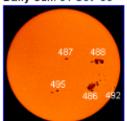
Solar Wind speed: 856.0 km/s density: 2.6 protons/cm³

explanation | more data Updated: Today at 2246 UT

X-ray Solar Flares

6-hr max: M1 1525 UT Oct30
24-hr: M1 0205 UT Oct30
explanation | more data
Updated: Today at 1955 UT

Daily Sun: 31 Oct '03



Sunspots 486 and 488 pose a continued threat for strong X-class solar flares. Image credit: SOHO MDI

Sunspot Number: 293 What is the sunspot number? Updated: 30 Oct 2003

What's Up in Space -- 31 Oct 2003

Subscribe to Space Weather News!

Would you like a phone call when auroras appear over your home town? Sign up for Spaceweather PHONE.



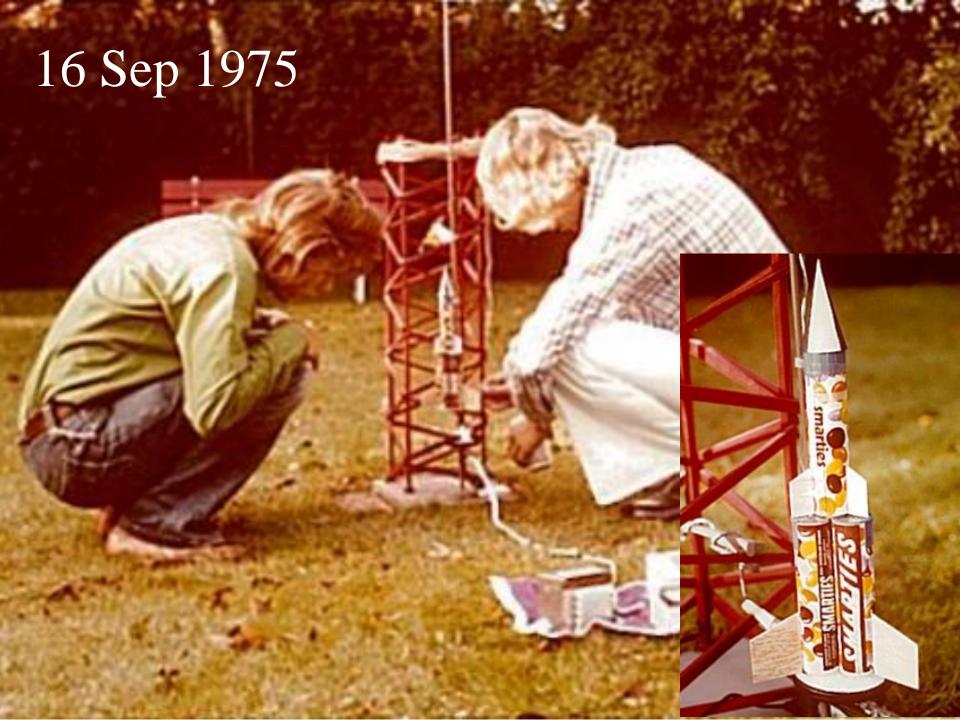
THE STORM IS OVER: After two days of mild-to-extreme geomagnetic storms, our planet's magnetic field is finally settling down. <u>High-latitude</u> observers should remain alert for intermittent auroras--but no widespread displays.

BRIGHT AURORAS: It's been a wonderful week for sky watchers. Two fast-moving clouds of gas from the sun (CMEs) swept past Earth--one on Oct 29th and one on Oct 30th--and sparked extreme geomagnetic storms. In Alabama, Lucille Petruny and Auburn University geology professor David King took this picture of pink-glowing auroras at sunset on Oct. 29th:



About myself

- Why I'm here as 3-yr visiting professor
- Why I'm interested in Space & the Sun
- What else I did



Die loo. Rakete

Die Zirkon 1 ist eine zweistufige Rakete. Die erste Stufe besteht aus drei Monopause-Boosterstufen (Tripause), die zweite Stufe ist eine Monopause.

Am Mittwoch (10.9.75) wurden Adapter gebaut.
Am Donnerstag bzw. Freitag wurden die
Tripause bzw. die Monopause gebaut. Am
Samstag war die Rakete dann startbereit.
Der Wind ließ jedoch einen Start erst am
Dienstag (16.) zu. Bereits am Vorabend
zeichnete sich eine wetterbesserung ab.
Somit wurden beauftragt Hendrikje Steffen
zum fotografieren des Starts (s.u.) Ingrid



Schreiber zum Aufnehmen von Serienaufnahmen des Starts. SFB zur Flüghöhenmessung, andere Personen zur Beobachtung der Flugbahn. Das Fot links zeigt den Sart der Zirkon. Der Tri - x - Fil wurde mit einen sehr hart arbeiten dem Astroentwickle r entwickelt. Daher sind leider keine Einzelheite: auf der Rakete sichtbar.

Die Stufentrennung der Zirkon nach 6.5 s in etwa 300 m Höhe über Heide.

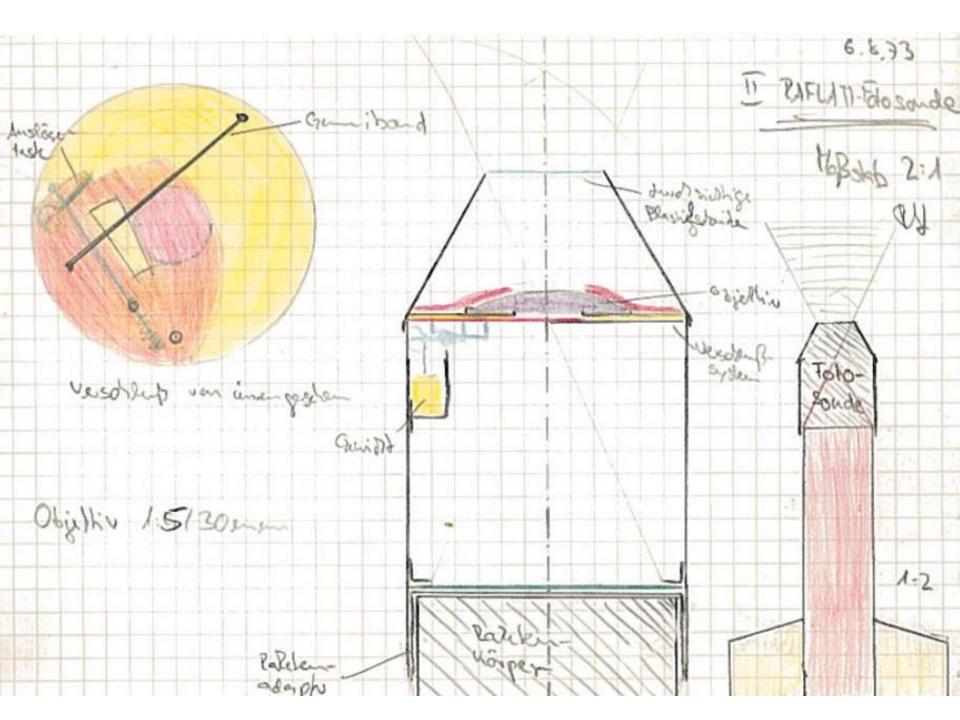


Der atemberaubende Anblick im Feldstecher

kommt dieser Fotografie schon recht nahe.

Wulf hat von der Bodenstation aus fotografiert.

Ob die Flugbahn in der Tat in solchen Schlangenlienien verlief ist nicht ganz gewiß!





...then, what did I do?

Where	Age	New things
School	7-19	Age 14-16 rockets, 17-18 astronomy
Alternate service	19-21	astrophotography
Hamburg University	21-27	Convection, linear theory, interest in aurora
Helsinki University	27-31	PhD, magnetic fields, 3-D simulations
Nordita in Copenhagen	31-33	Accretion discs, supervised student
Newton Institute Camb.	33	In-depth exposure to many scientists
NCAR, Boulder, Colorado	33-35	Galactic magnetic fields, turbulence
Nordita, (assistant prof)	35-37	Early Universe, organized school,
Newcastle (professor)	37-41	Teaching courses, project + PhD students
Nordita (professor)	41-47	Astrobiology, Pencil Code
Nordita (Stockholm)	47-(54)	Big European grant, own group, visitors



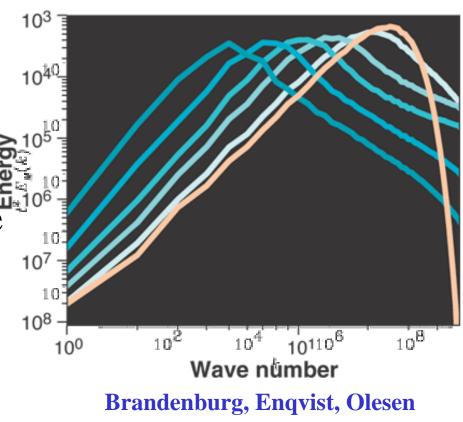
Time to be a post-doc (left) only once



Crucial to get around the word Helps if your partneris not scientist too!

B-field from electroweak phase transition: parity breaking -> helical

- Time 10^-10 sec
- Horizon scale 3 cm
- Now $\sim 1 \text{AU} \rightarrow \text{small}$
- Helicity → inv cascade
- Quark-gluon plasma: → high conductivity
- Standard MHD eqn with conformal time

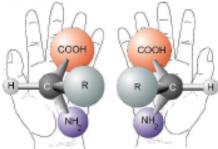


Phys Rev D 54, 1291 (1996)

Er det en naturlov at aminosyrer er venstredrejede?

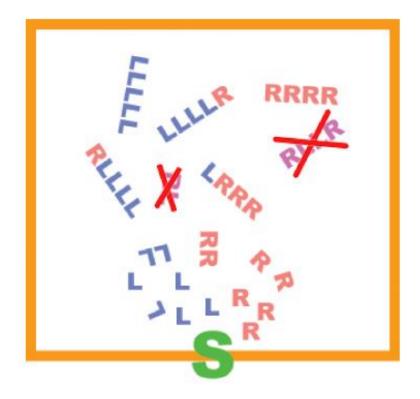
Anja C. Andersen, Axel Brandenburg og Tuomas Multamäki, NORDITA

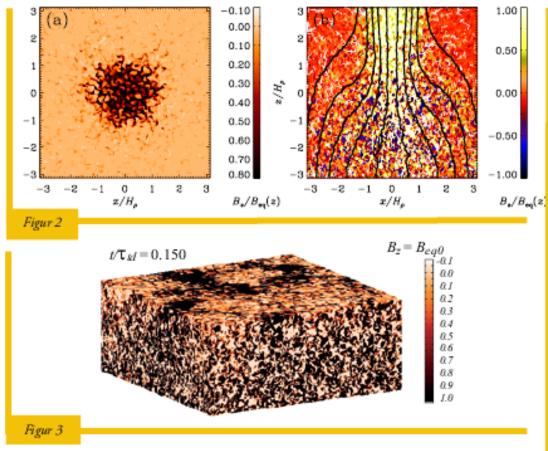
Stort set samtlige aminosyrer¹ findes i to udgaver, som er enantiomere – en venstredrejet og en højredrejet, der er hinandens spejlbilleder (se figur 1). De aminosyrer som indgår i opbygningen af levende organismer er alle venstredrejede. Dette fænomen betegnes homochiralitet, der betyder 'samme chiralitet'. Umiddelbart er der ikke noget der taler for, at livet ikke lige så godt kunne bestå af højredrejede aminosyrer. Så man kan spørge om det er et tilfælde, at det kun er halvdelen af de tilgængelige aminosyrer, der benyttes af de levende organismer vi kender til, eller om der er noget særligt der gør, at kun venstredrejede bruges i opbygningen af liv? Er dét, at alle levende væsener benytter samme slags, et tegn på, at det er den eneste mulighed eller betyder det, at levende organismer på Jorden alle har samme oprindelse?



Figur 1. En 2-aminosyre kan have to stereoisomere former. Aminosyrer der indgår i levende organismer er alle Laminosyrer, hvis rumlige struktur ses til venstre. R betegner en sidekæde, der varierer ganske meget fra aminosyre

lys. Forbindelser, der drejer lyset venstre om betegnes L – afledt af latin; laevus (=venstre), mens forbindelser der drejer lyset til højre får betegnelsen D – fra latin dexter (=højre). Forskellen på L-aminosyrer og D-aminosyrer er, at H-atomet og aminogruppen, NH₂, på kulstofatom nr. 2 har byttet plads (se figur 1 – det kræver drejning om flere akser for at indse!).



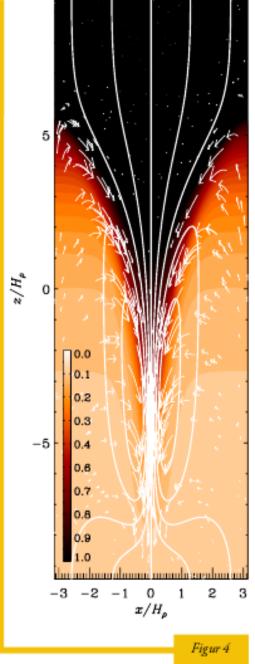


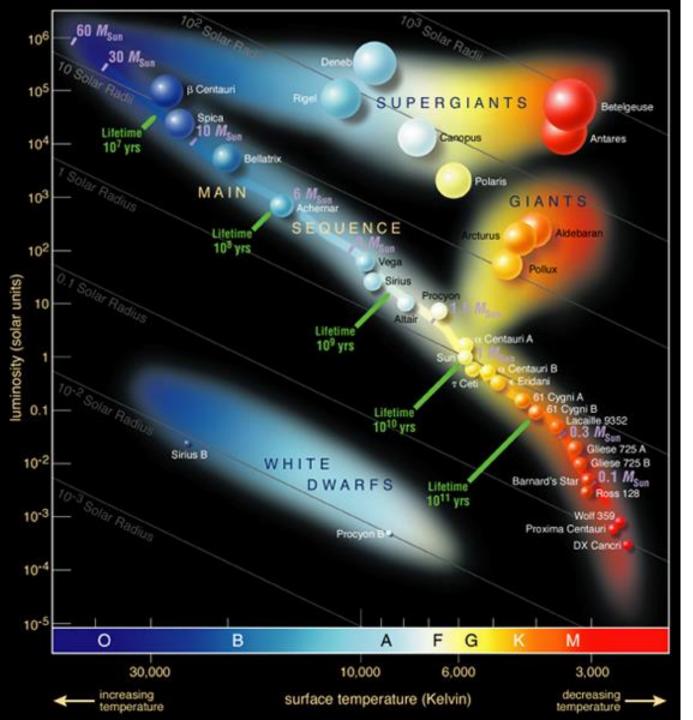
SOLFLÄCKAR

Sökandet efter en ny teori för solfläckar

mer frekventa på andra stjärnor där man också har observerat cykliskt varierande

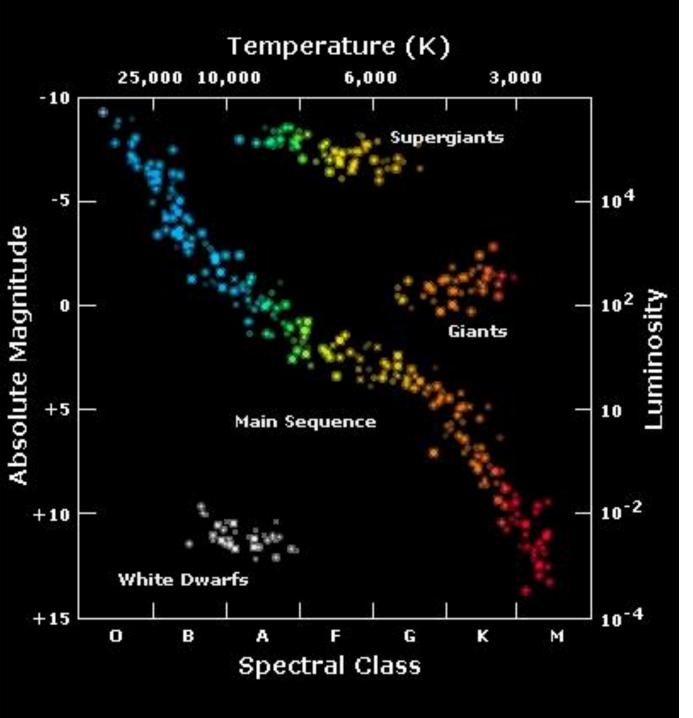
Ett exempel på resultat av sådana beräkningar visas i fig. 4, som visar en solfläck





The Sun in the HR diagram

- $L=3.8\times10^{26}W$
- $T_{\rm eff} = 5778 {\rm K}$



HR diagram

- $M=-2.5 lg L/L_0$
- $M=M_{bol}$
- $L_0 = 3 \times 10^{28} \text{W}$
- Distance = 1AU
- $1AU=1.5x10^{11}m$

