

**Prof. M. Vukičević-Karabin (1933-2020):
beogradska škola astrofizike i istraživanja u
fizici Sunca i Zemljine jonosfere**

Istraživačka delatnost

I. Vince

Beograd, 1. decembar, 2020

Podela istraživačkog rada

- Poremećaji jonosfere Zemlje (TID, SID)
- Kretanje materije velikih razmera na Suncu
- Spektrofotometrija Sunca kao zvezde

Početak istraživačke delatnosti

- 1956 - zaposlila se u Institutu "Mihajlo Pupin" – meri/istražuje poremećaje jonosfere Zemlje. ...
- 1962/63 - boravi na usavršavanju u National Physical Laboratory, New Delhi, Indija – jonosferski poremećaji.
- Rezultati tog boravka: dva članka u časopisu *Journal of Atmospheric and Solar Terrestrial Physics (JATP)* i prikupljen materijal za doktorsku disertaciju.

Uticaj eksplozije atomske bombe na jonosferu

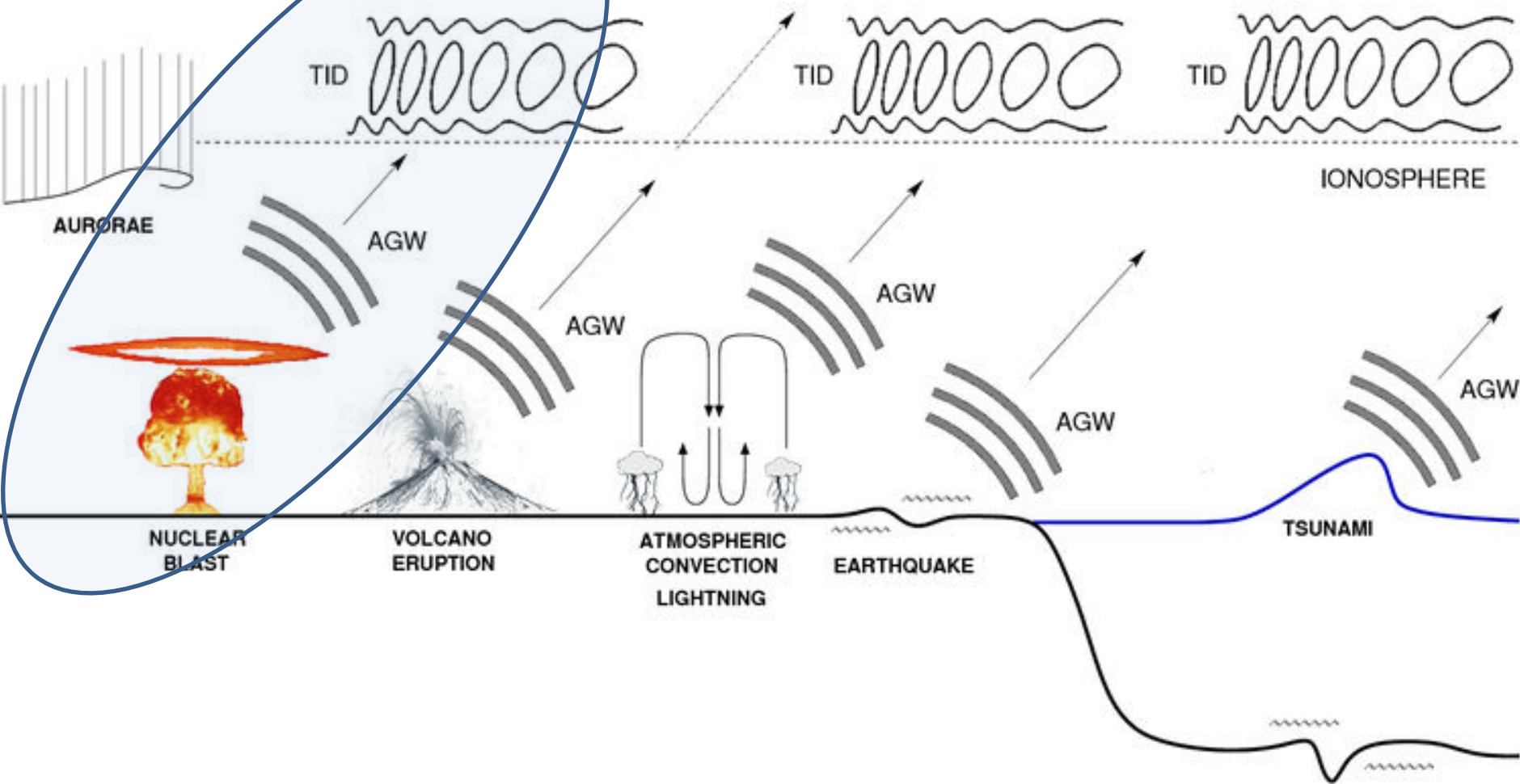
- [Ionospheric effects following distant nuclear detonations](#)

Saha, A. K.; Karabin, Mirjana; Mahajan, K. K.

[1963JATP...25..212S](#)



Prolazni (transient) jonoferski poremećaji (TID)



Uticaj eksplozije atomske bombe na krivu raspodele frekvencije foF2

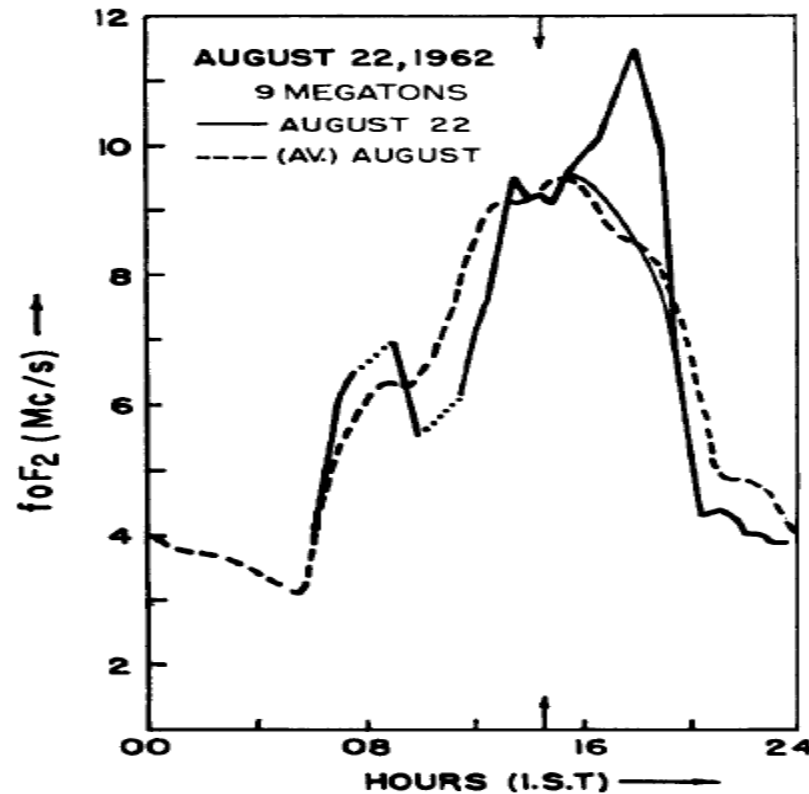


Fig. 1. Shows a typical f_oF_2 curve for a detonation day compared to average curve for the month, calculated after omitting the days on which detonations were reported.

Razlika oblika krive promene intenzita reflektovanog radio-signala od jonosfere izazvana flerom i eksplozijom atomske bombe

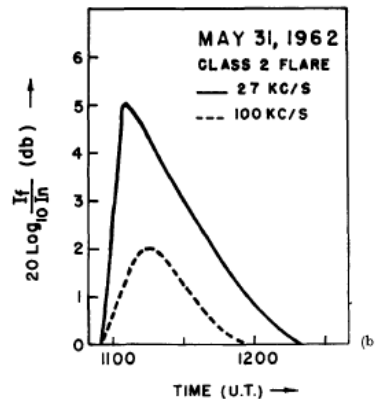
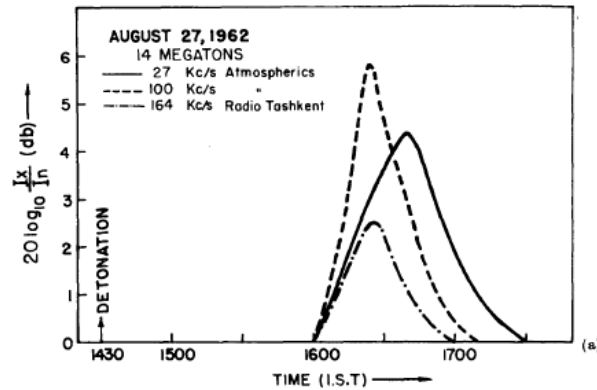


Fig. 4. Illustrates the enhancement effects observed at low and very low frequencies for (a) a detonation case and (b) a typical class 2 flare case. The reversal in relative magnitudes of 27 Kc/s and 100 Kc/s may be noted.

Nivo fluksa zračenja Sunca oko 3000 MHz (10 cm) u relaciji sa pojavom SID-a

- Samo one erupcije na Suncu izazivaju SID, koje nastaju u periodu kad je srednja dnevna vrednost radio-fluksa Sunca u centimetarskom domenu iznad određenog praga. Određen je prag za 3 GHz za period Geofizičke godine:

$$220 \text{ SFU (SFU=10}^{-22} \text{ W/(m}^2 \text{ Hz))!}$$

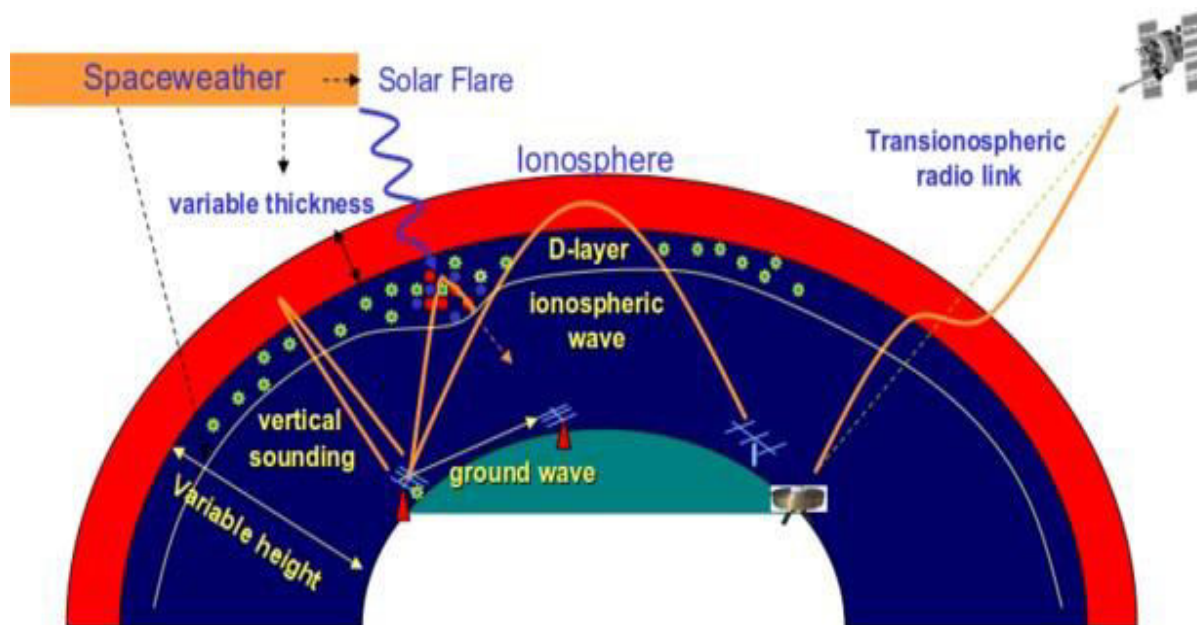
- **Level of solar radio flux in the 3000 Mc/s region and its relation to the occurrence of sudden ionospheric disturbances**

[1964JATP...26.1138M](#)

Mitra, A. P.; Subrahmanyam, C. V.; Karabin, Mirjana

Erupcije i iznenadni jonosferski poremećaji (SID)

- Prilikom erupcija na Suncu dolazi, među ostalog, i do povišenog nivoa elektromagnetnog zračenja u UV- i X- (γ -) oblasti.
- Ta zračenja u interakciji sa jonosferom Zemlje dovode do povećanja broja naelektrisanih čestica u njoj, pa utiču i na jačinu prijema radio signala (SID).



SID-ovi i 3 GHz radio fluks

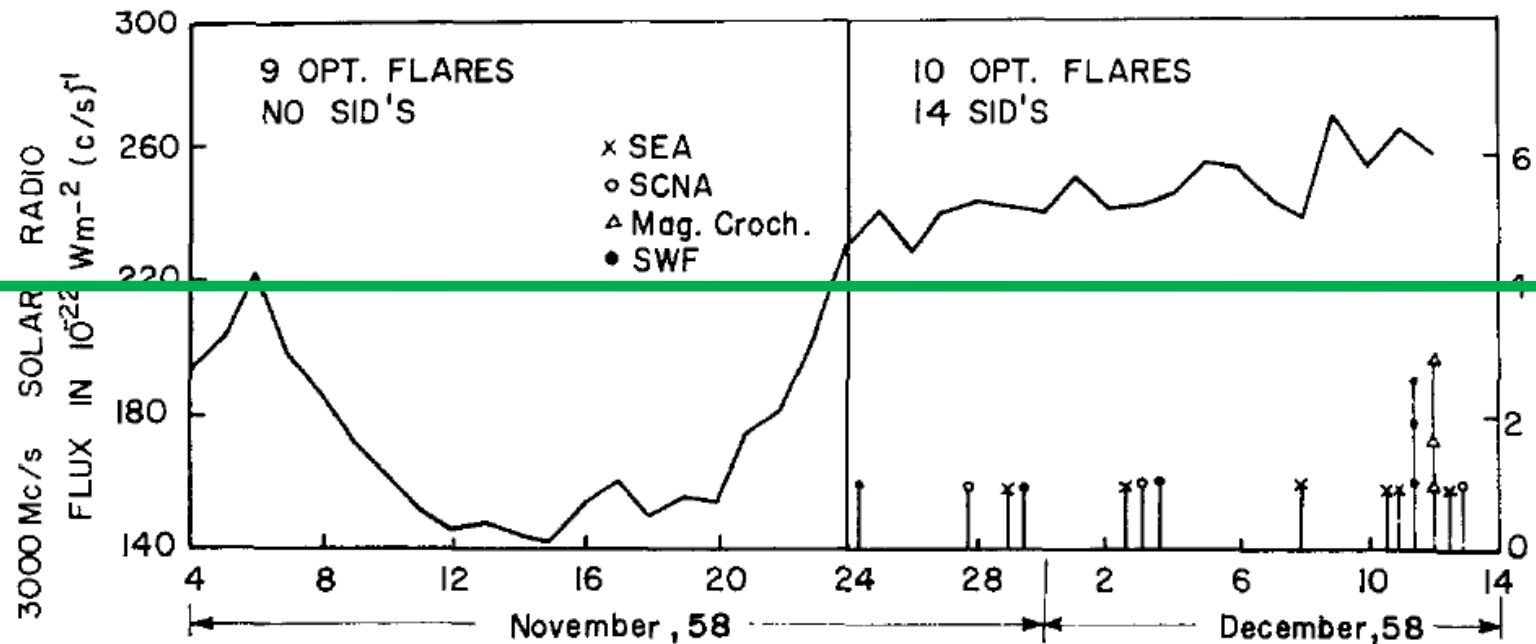


Fig. 4. Mean daily values of solar radio flux at 3000 Mc/s against days during the period 4 November–14 December 1958. On the same is also plotted the various SID's occurring during the period.

Jonosfera  Sunce

Nakon prelaska sa Instituta Mihajlo Pupin na Katedru za astronomiju Mirjanin naučni interes polako se usmerava ka izučavanju spektra Sunca. Zadnji eksperiment iz oblasti jonosfere se datira iz 1972.

Solar flares in August 1972 followed by atmospheric phenomena of the earth.

Publications de l'Observatoire Astronomique de Beograd, No. 20, p. 55 – 61, 1975

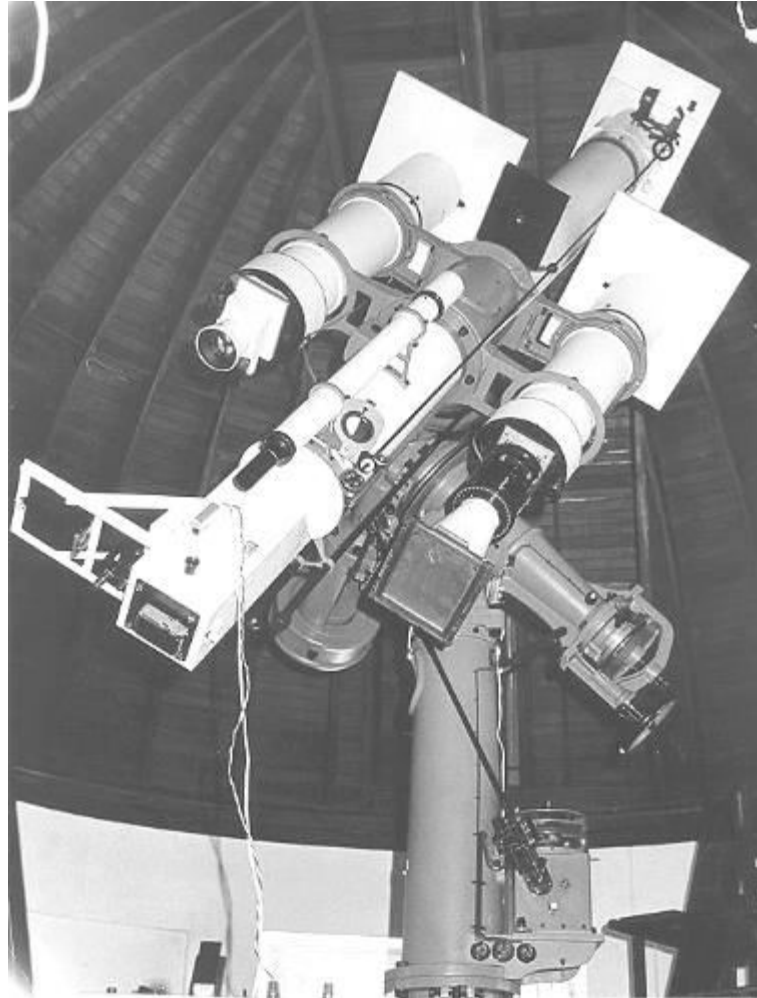
*Radio-interferometar Astrofizičke laboratorije Prirodno-
matematičkog fakulteta - 1962*



Prelazak na novu temu:

- Kretanje materije velikih razmera na Suncu (reda poluprečnima Sunca) - ~1975

Sunčev spektrograf Astronomske opservatorije u Beogradu



Optičko usrednjavane radialnih brzina oscilatornih, granularnih i supergranularnih kretanja

Fit Width

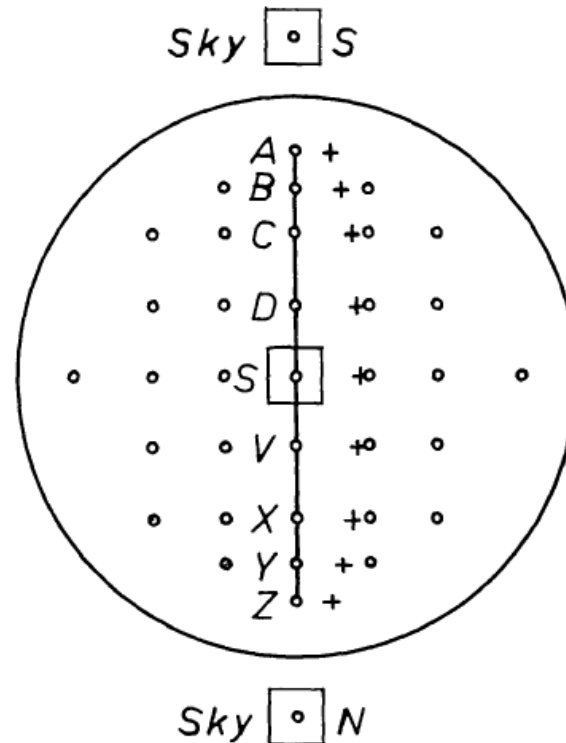


Fig. 1. Observed points (A to Z) on the solar disc and outside the disc (Sky S and Sky N). The squares around S and the sky points represent the estimated area of integration of radiation (the applied space resolution). The same squares around the other observed points are not shown.

Asimetrija sjever-jug krive radialne brzine (RB).
Ne-monotona promena RB sa heliocentričnim uglom.

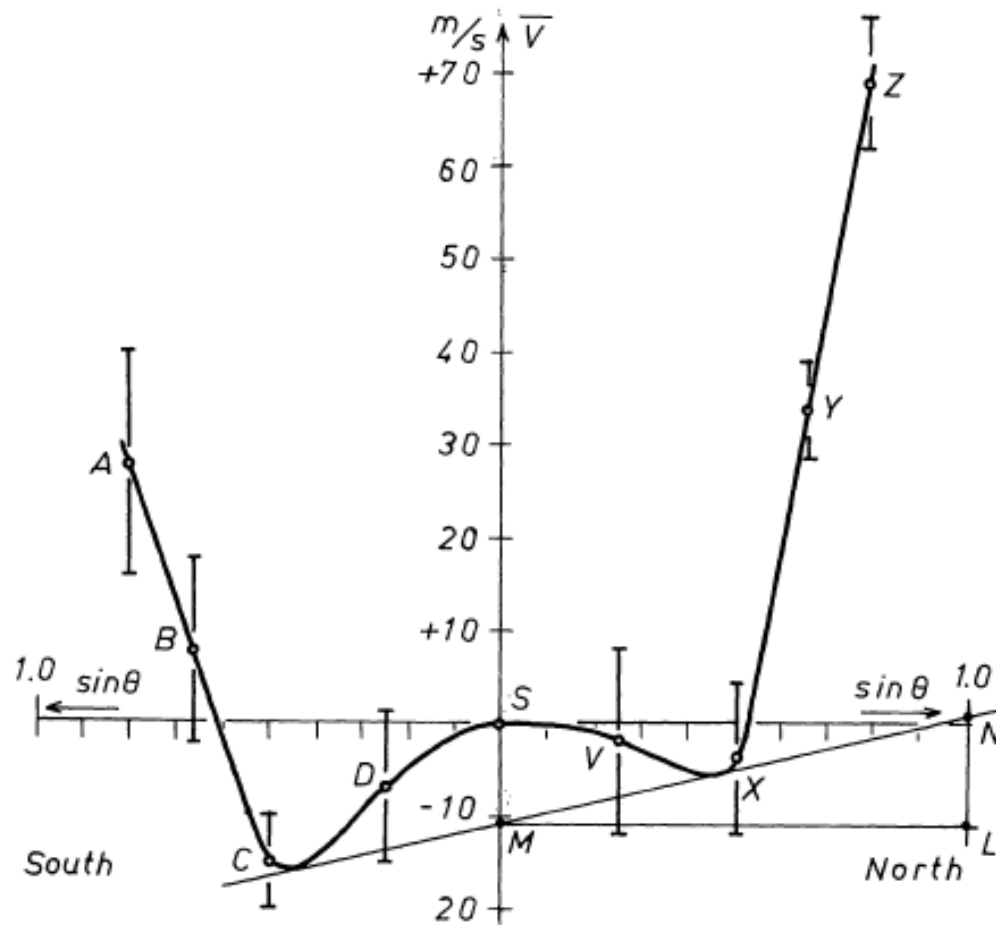


Fig. 2. Combined limb effect (A to Z) and evaluation of dB_0/dt (as NL).

Kubičela, A.; Karabin, M.: 1975, **Apparent yearly precession of the Sun**, Solar Physics, Volume 54, Issue 2, pp.505-509

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A. KUBIČELA AND M. KARABIN

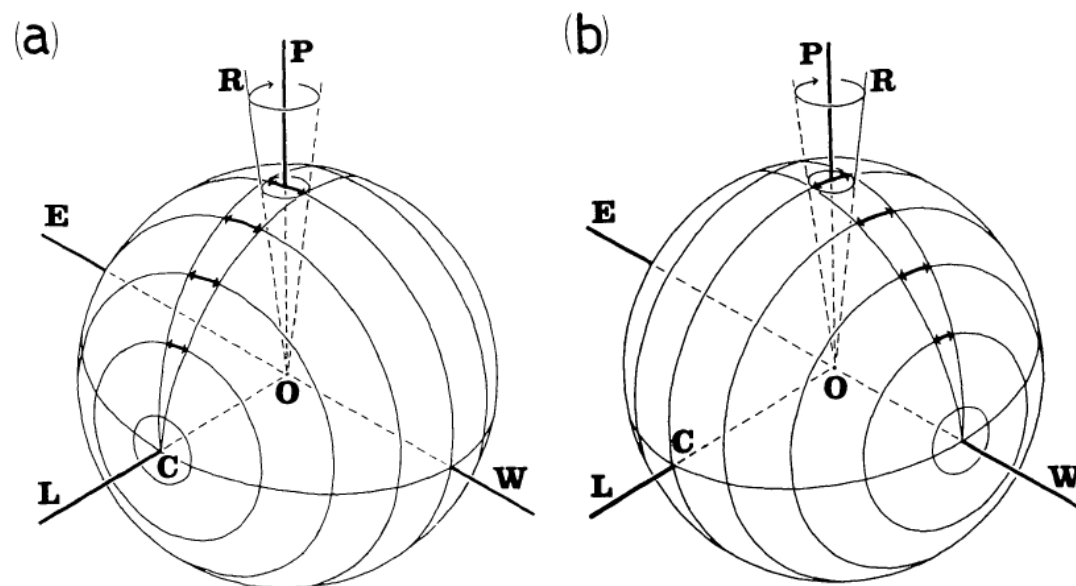


Fig. 1. Two oscillatory components of the apparent yearly precession of the Sun. \overline{OP} = direction toward the ecliptic pole, \overline{OR} = the axis of solar rotation, \overline{OL} = the line of sight, C = centre of the solar disk, $E-C-W$ = the ecliptic plane. Double-ended arrows represent the yearly amplitude of the angular oscillatory displacements of the solar globe. (a) Apparent rotation around the line of sight. No line-of-sight velocity effect occurs. (b) Apparent rotation around the east-west ecliptic diameter of the Sun (\overline{EW}). The line-of-sight velocity components are present.

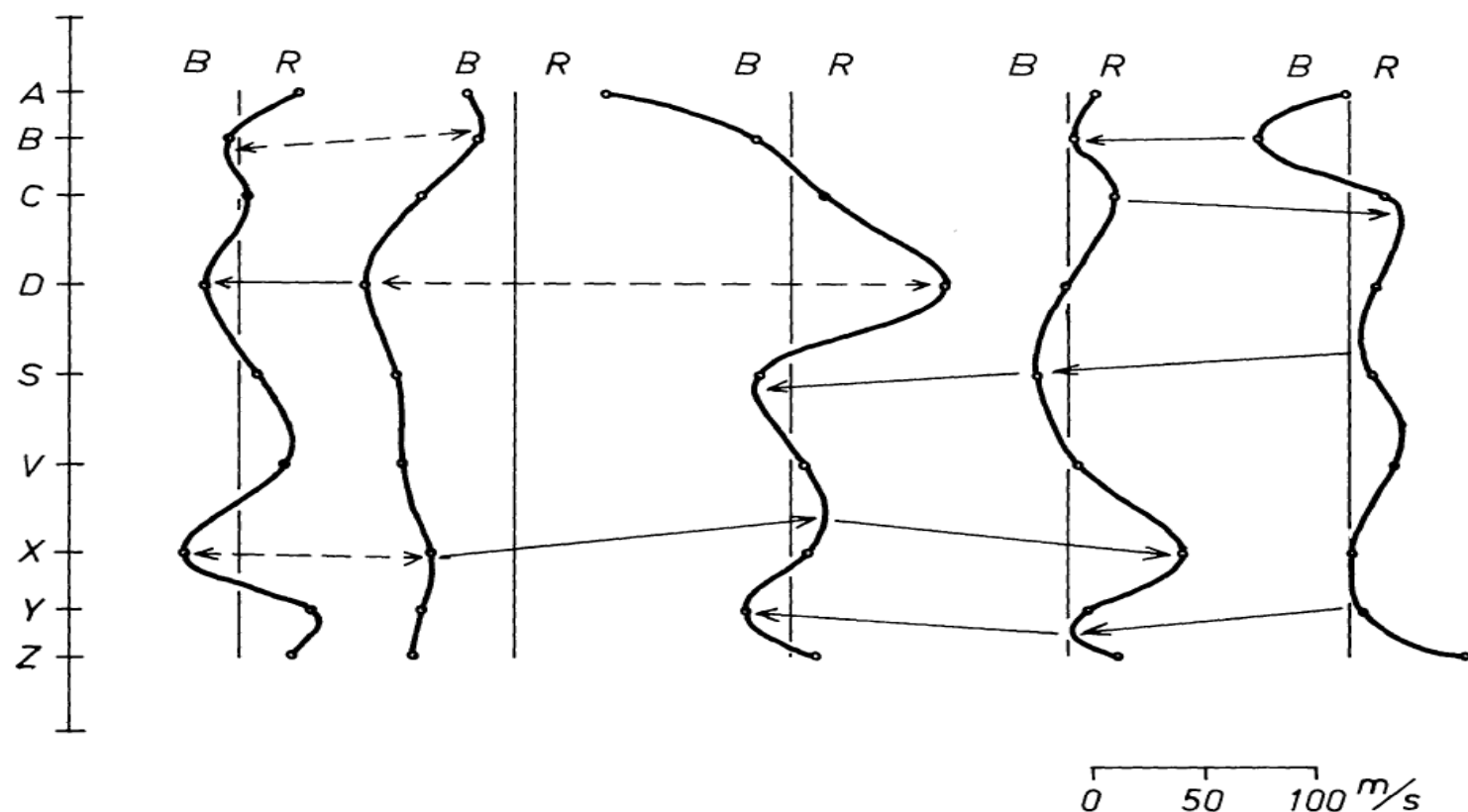


Fig. 4. Photospheric large scale velocities from January 15 to 19. From A to Z – distribution of the observed points along the central meridian. To the right – velocity diagrams: B – blue-shift, R – red-shift. Bottom – velocity scale.

Novi smer istraživanja: Sunce kao zvezda

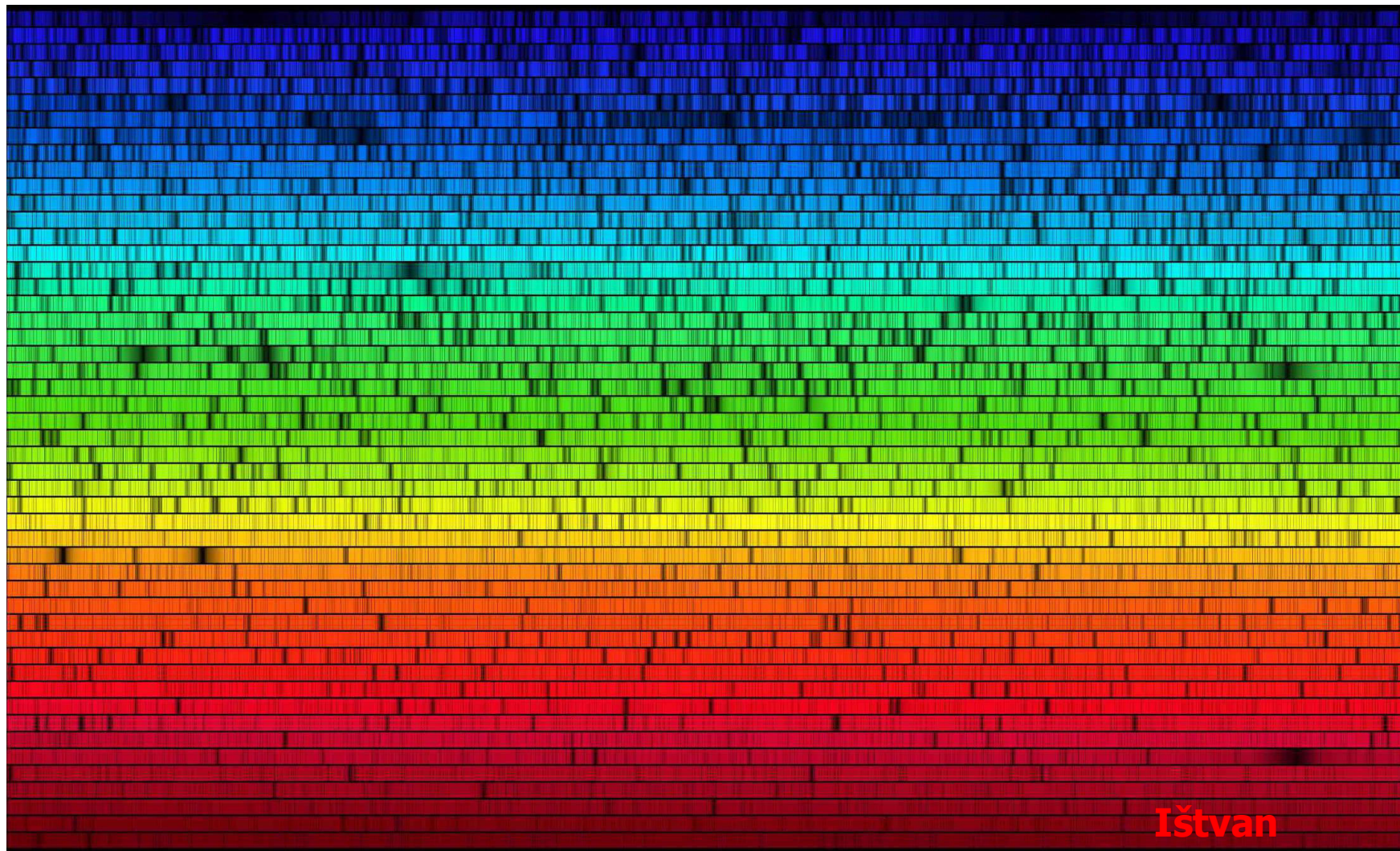
Vukićević-Karabin, M., Arsenijević, J.: 1986, *Bull. Astron. Obs. Belgrade*, 136, 53.

"Solar and stellar activity phenomena"

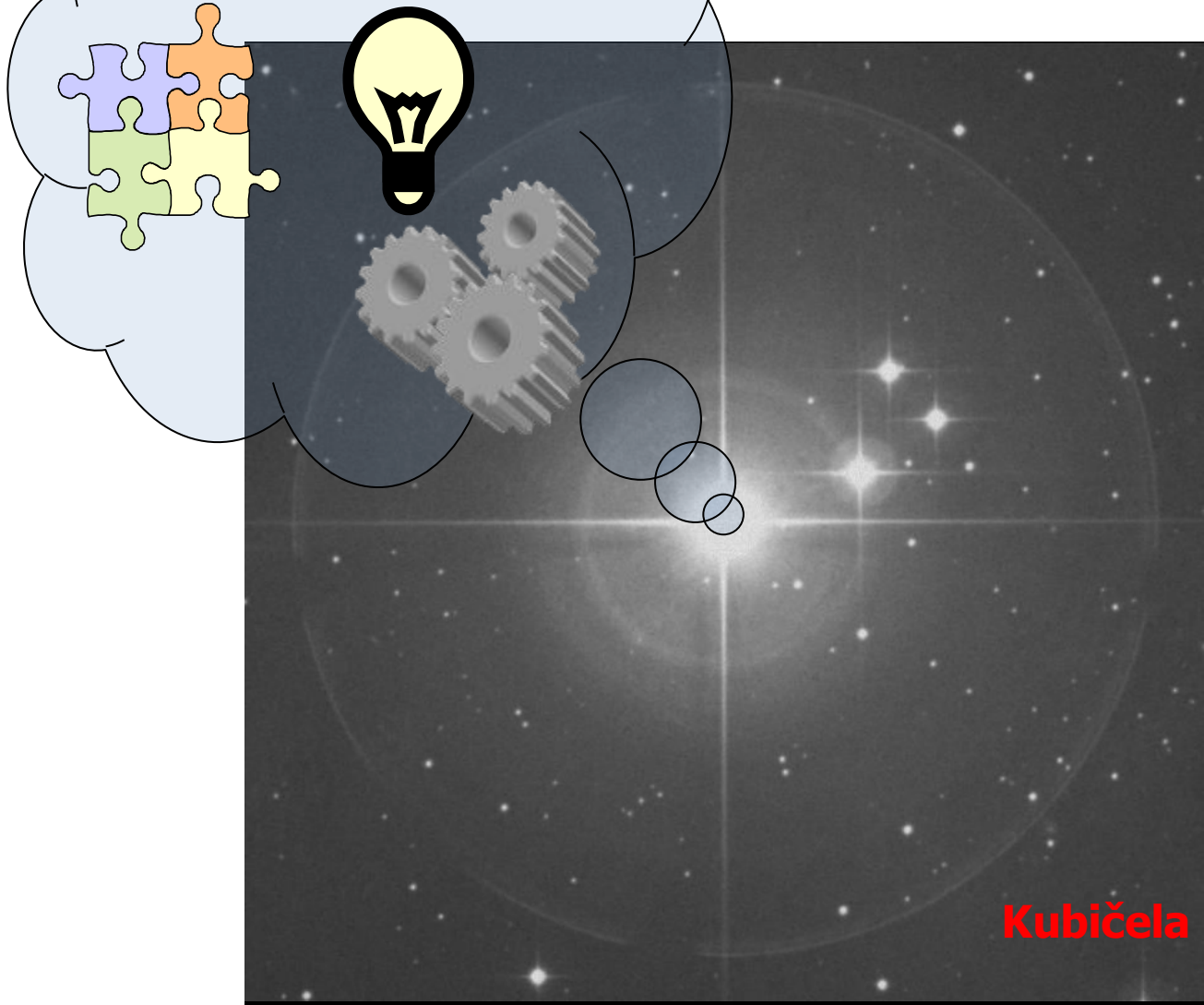
Arsenijević, J., Karabin, M., Kubičela, A., Vince, I.: 1987, 5th *European Meeting on Solar Physics, Tlilisee*.

et al, 1988). So-called "Belgrade Program for Monitoring of Activity-Sensitive Spectral Lines of the Sun as a Star" started in August 1987 and is still going on.

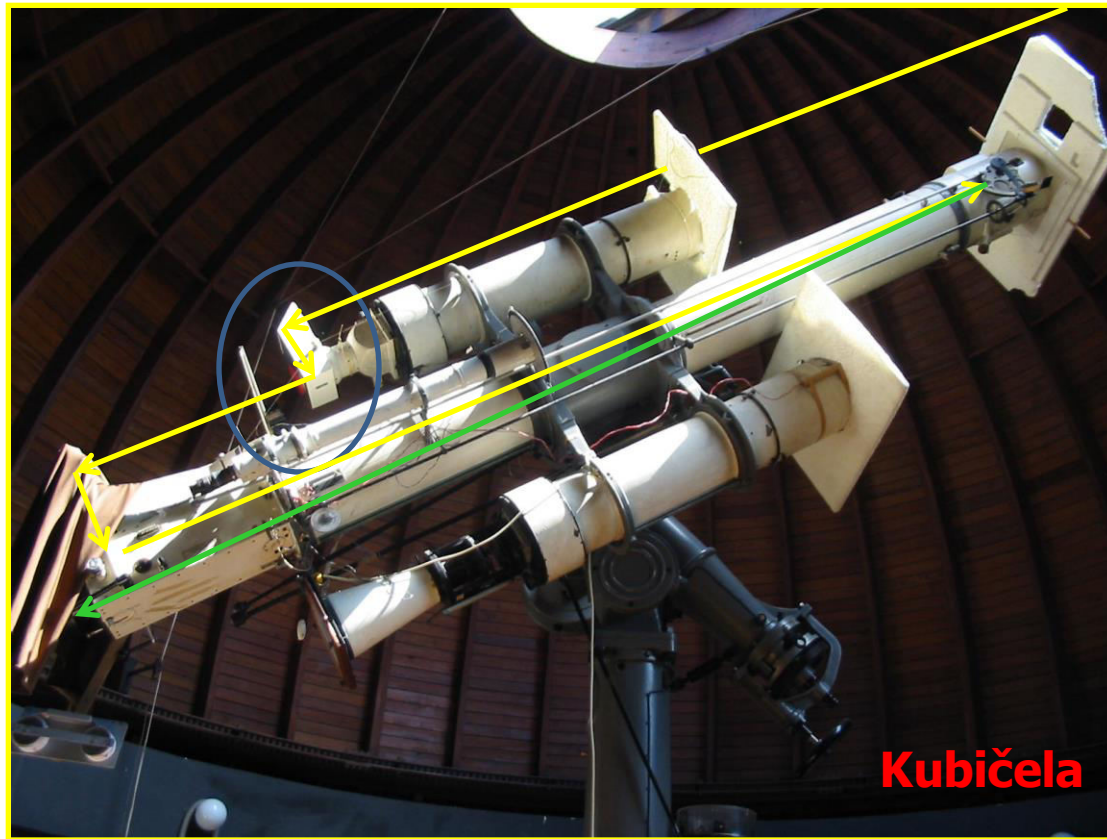
Izbor spektralnih linija (~30)

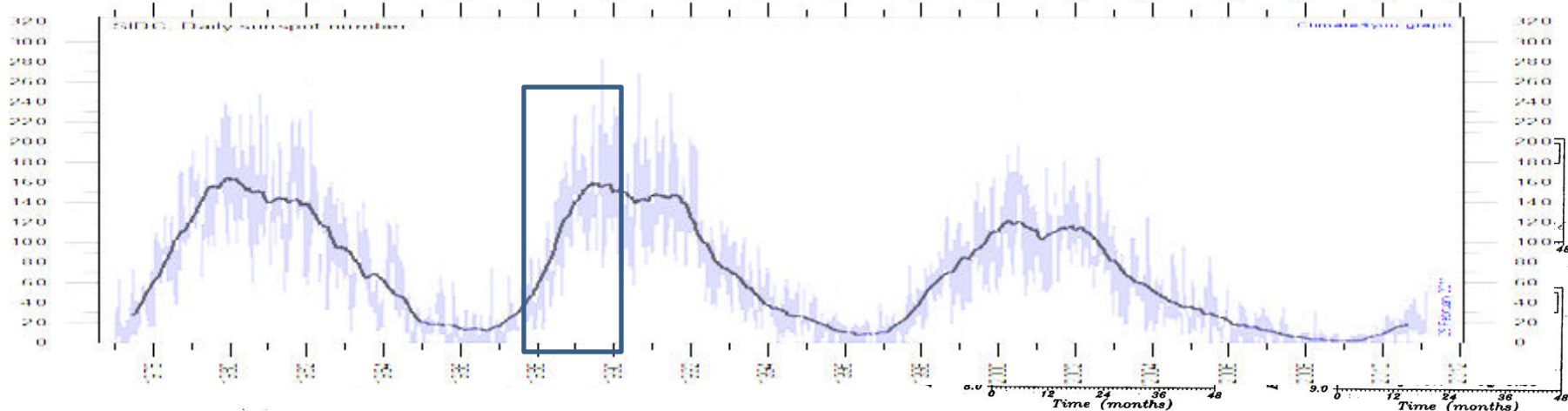


Kako pretvoriti Sunce u zvezdu?



**Litrow spektrograf Astronomske Observatorije u
Beogradu prilagođen je posmatračkom programu
“Belgrade Program for Monitoring of Activity-sensitive
Spectral lines of the Sun-as-a-star ”**





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² Astronomical Observatory, Volgina 7, YU-11050 Belgrade, Yugoslavia

(Received: January 10, 1991)

SUMMARY: Changes of equivalent widths for ten selected spectral lines ($530.74 \text{ nm} \leq \lambda \leq 568.82 \text{ nm}$) were evaluated according to "Belgrade Program for Monitoring of Activity-Sensitive Spectral Lines of the Sun as a Star". Observations from August 1987 till May 1990 have been processed in the way for the first time presented here.

Three lines show steady and pronounced increase of W with activity:

$\lambda_2 = \text{TiII } 533.68 \text{ nm}$ (+5.5% per year),

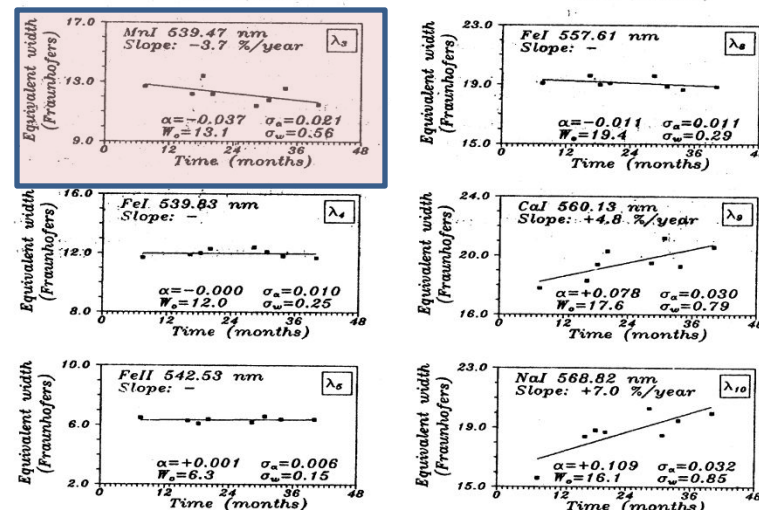
$\lambda_9 = \text{CaI } 560.13 \text{ nm}$ (+4.8% per year) and

$\lambda_{10} = \text{NaI } 568.82 \text{ nm}$ (+7.0% per year).

Two lines show steady decrease of W with activity:

$\lambda_3 = \text{MnI } 539.47 \text{ nm}$ (−3.7% per year) and

$\lambda_7 = \text{ScII } 552.68 \text{ nm}$ (−2.4% per year).

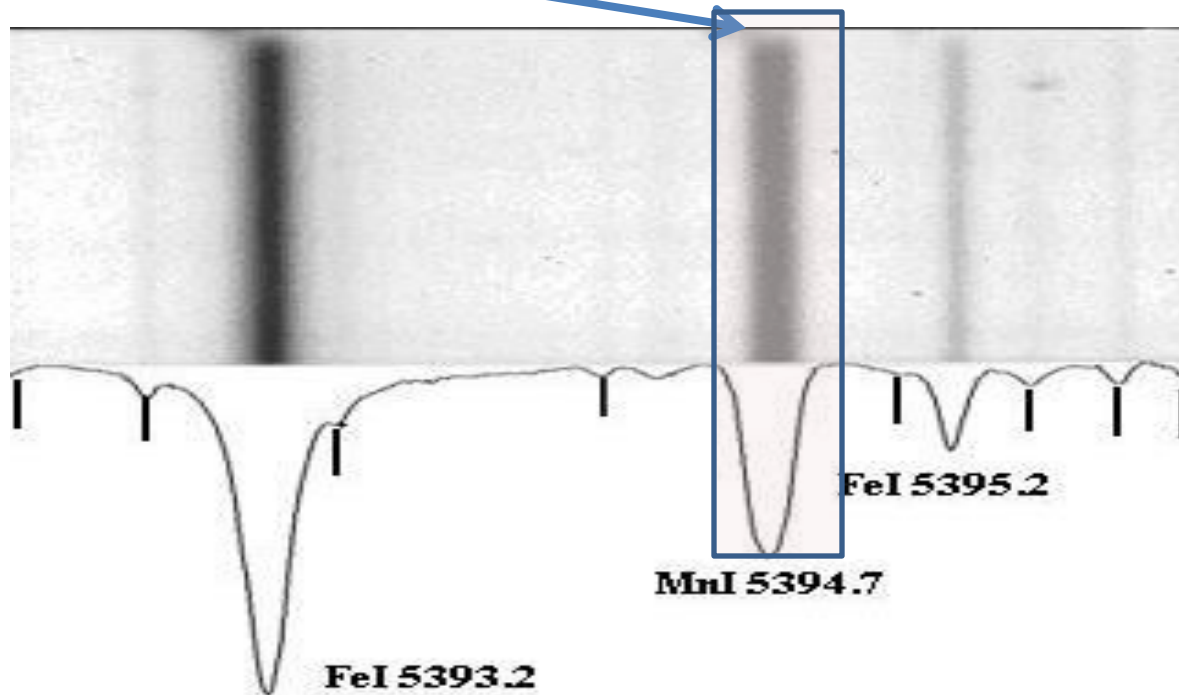


4. Trend of changes of equivalent widths with the Solar activity.

Показане су промене еквивалентних ширина за десет изабраних спектралних линија ($530.74 \text{ nm} \leq \lambda \leq 568.82 \text{ nm}$), према "Београдском програму за

праћење активно-осетљивих спектралних линија Сунца као звезде", за период август 1987 — мај 1990.

Privuklo nam je pažnju opadanje ekvivalentne širine (EW) MnI 5394.7 Å linije sa vremenom, što se poklopilo sa fazom rasta aktivnosti Sunca, i **neobičan oblik profila!**



Saradnici na temi: Sunce kao zvezda



- 1 Arsenijević Jelisaveta
- 2 Danilović Sanja
- 3 Erkapić Sanja
- 4 Gošić Milan
- 5 Jevremović Darko
- 6 Jovanović Miljana
- 7 Jovanović Predrag
- 8 Kršljanin Vladimir
- 9 Kubičela Aleksandar
- 10 Latković Olivera
- 11 Martinović Nemanja
- 12 Popović Luka
- 13 Popović Mila
- 14 Skuljan Jovan
- 15 Stojadinović Jovan
- 16 Vince Ištvan
- 17 Vince Oliver
- 18 Vitas Nikola
- 19 Vučković Maja
- 20 Vukicević-Karabin Mirjana



Debrecen



Utrecht



Terskol



Beograd



Hinode



Mount Cook Observatory-
Christchurch

