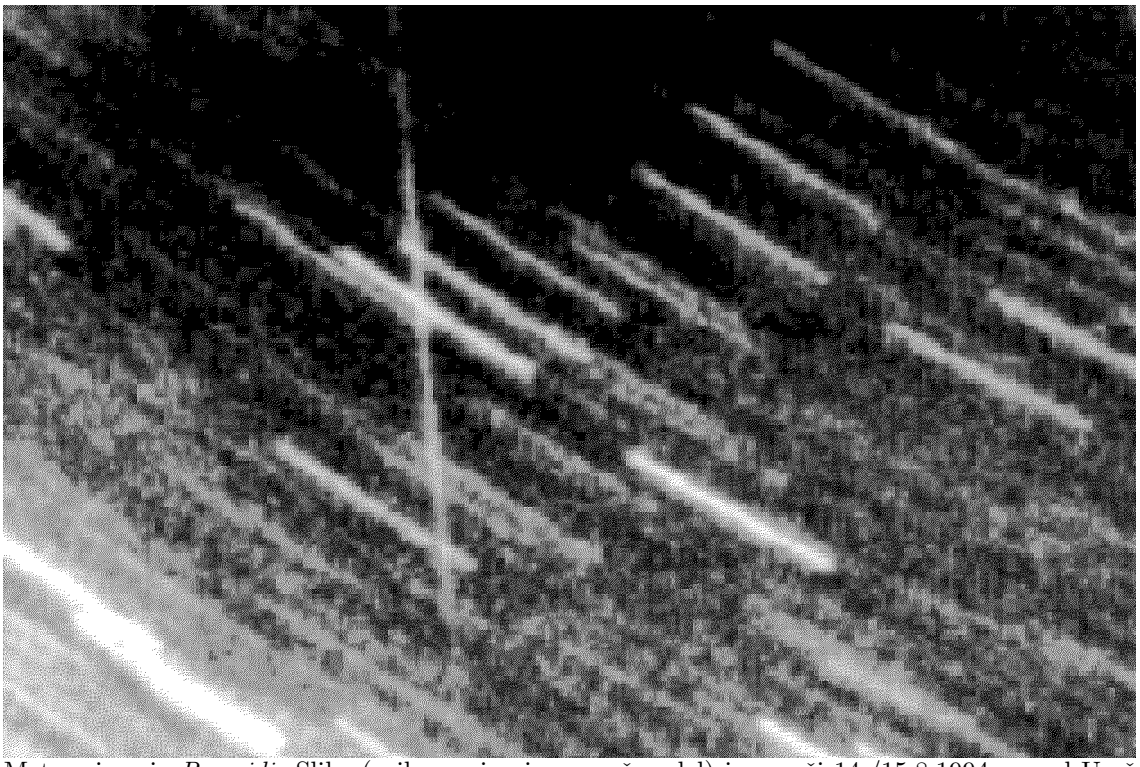
ZVEZA ORGANIZACIJ ZA TEHNIČNO KULTURO SLOVENIJE
GIBANJE ZNANOST MLADINI

Ne verjamem, da so zvezde posejane po nebesni krogli v enaki oddaljenosti od njenega središča. Domnevam, da so njihove razdalje od nas tako različne, da se nekatere nahajajo celo dva ali trikrat dlje kot druge.

– *Galileo Galilei*

PAMET'94

POLETNI ASTRONOMSKI METEORSKI TABOR '94



Meteor iz roja *Perzeidi*. Sliko (prikazan je njen povečan del) je v noči 14./15.8.1994 posnel Uroš Čotar na Javorniku. Objektiv: 20 mm $f/3.5$, film: Kodak TMax 3200, ekspozicija od $23^{\mathrm{h}}55^{\mathrm{m}}$ do $00^{\mathrm{h}}05^{\mathrm{m}}$ UT.

Astronomsko društvo Javornik,

Zveza organizacij za tehnično kulturo slovenije (ZOTKS),

Študentska organizacija Univerze v Ljubljani (ŠOU),

Kolinska,

Kodak Meditrade,

- Slovenijavino,
- TSE,
- Žito Ljubljana.

Naslov: PAMET'94 — Poletni Astronomski MEteorski Tabor 1994
Avtorja: Aram Karalič, Urška Pajer
Založnik: Astronomsko društvo Javornik, Tavčarjeva 2, Ljubljana, Slovenija, 1994.

Povzetek

Knjižica opisuje priprave in izvedbo opazovanj meteorskega roja *Perzeidi* v letu 1994 ter prve rezultate njihove obdelave. Opazovanja smo v celoti izvedli člani *Astronomskega društva Javornik* na Poletnem Astronomskem MEteorskem Taboru **PAMET'94**.

Opazovali smo vizualno, fotografsko in z videokamero. Iz opazovanj *vizualne skupine* smo izračunali spreminjanje ZHR (standardizirana mera za aktivnost meteorskega roja). Diagram ZHR lepo pokaže postopno naraščanje aktivnosti, maksimum in upadanje aktivnosti. *Fotografska skupina* je posnela tri meteorje — en Perzeid in dva Akvarida. En meteor je posnet skozi propeler, kar nam omogoča, da lahko natančno določimo njegovo trajanje. Vse posnete fotografije se nahajajo v poročilu. *Video skupina* je posnela dva meteorja, od tega en Perzeid.

Rezultati zelo dobro dopolnjujejo rezultate opazovalnih skupin po vsem svetu, posebej pomembni pa so, ker smo ena izmed redkih evropskih skupin, ki ji je v tem času kljub slabemu vremenu uspelo uspešno izvesti opazovanja.

Abstract

Observation of 1994 appearence of the Perseid meteor shower, as well as some evaluations of the observations is described. Observations were carried out by Slovene Amateur Society *Javornik*.

Perseids were observed visually, photograohically, and by video-camera. ZHR profile, derived from the results of visual group, clearly shows gradual increasing of activity, its peak and decline. Fotography group managed to capture three meteors on film — one Perseid and two Aquarids. One of the pictures is taken through shutter, which enables us to accurately determine meteor's duration. All pictures are included in the report. Video group recorded two meteors, one Perseid.

The results very well supplement the results of other observing groups all over the world. We consider our observations especially important, because we were one of the very few European groups which managed to perform the meteor watch despite the bad weather.

Kazalo

Zahvala

Tabor je organiziralo Astronomsko društvo Javornik v okviru *Gibanja Znanost Mladini*.

Tabor so podprli:


Zveza organizacij za tehnično kulturo slovenije (ZOTKS),

Študentska organizacija Univerze v Ljubljani (ŠOU),

Kolinska,

Kodak Meditrade,

- Slovenijavino,
- TSE,
- Žito Ljubljana.

Vsem se najlepše zahvaljujemo, saj brez njih tabora ne bi mogli izpeljati.

Aram

Kaj smo pričakovali

Vsi smo tudi letos nestrpno, optimistično, vendar pa malo bolj skeptično kot lani, pričakovali meteorski roj Perzeidi. Tokrat so bili najbolj na trnih Američani, kar lahko vidimo iz obvestila v tedenskem biltenu revije *Sky & Telescope*:

```
==============================================================================
SKY & TELESCOPE NEWS BULLETIN -- August 6, 1994
==============================================================================

...

PERSEID ALERT!

The Perseid meteor shower is due to peak late Thursday night for North
America, and this is one not to miss!  There's every reason to believe it
could match last year's excellent show -- two British astronomers
even predict that this week's display will surpass last year's.
And *this* time North America should be ideally positioned.  In 1993
Europe and the Atlantic Ocean had the best seats.  You'll need to
follow two guidelines for good results.  First, observe under a sky as free
as possible from light pollution.  Second, do it very late at night -- at
least after midnight, and preferably between 2 a.m.  and dawn Friday
morning August 12th.  With luck, you might see several meteors every minute.
```

Tudi Mednarodna Meteorska Organizacija (IMO) je v pričakovanju velikega dogodka objavila sporočilo za tisk, ki predvideva maksimum aktivnosti med 8^{h} in 12^{h} UT. Sporočilo si lahko ogledate v Prilogi A.

Kako smo se imeli na taboru[1]

"V noči z 11. na 12. avgust so bili ZHRi Perzeidov normalni, torej 50–100 na uro. Okrog 9^h UT pa se je ZHR začel povečevati in zrasel do številke 250–300. Do 11^h UT se je spustil nazaj na normalno pogostost 50–100 meteorjev na uro." IMO, 1994 Perseid Bulletin #1 (Glej Prilogo B).

Tako Američani, ki so bili letos lahko priče višku aktivnosti meteorskega roja Perzeidov. Pri nas je v tistih urah žgalo poletno sonce (ali pa je morda deževalo — vsekakor pa je bil dan). Lani, torej leta 1993, pa je bila situacija povsem drugačna.

Lanski Perzeidi so bili res fantastični! Komet Swift-Tuttle, ki je vir teh meteorjev (kometi so člani našega sončnega sistema in nekateri krožijo po eliptičnih tirnicah okoli Sonca; za seboj puščajo sled iz kamenja in ledu, skozi katero vsako leto ob tem času potuje Zemlja — delčki ostankov kometa v atmosferi zažarijo in to mi vidimo kot utrinek), se je lansko zimo po približno 135 letih spet zapeljal prav blizu Zemljinega tira in pustil za sabo svežo sled. Tako je bilo pričakovati povečano aktivnost roja, nekateri pa so napovedovali celo meteorski dež. Celo NASA je zbirala podatke o roju in 'protimeteorsko' zaščitila vesoljski teleskop Hubble. Naši astronomi z Javornika so bili prvi, ki so jim poslali podatke (vendar je treba upoštevati, da so imeli pol dneva prednosti pred Američani; pri nas je bila namreč prej noč).

Na ta velik dogodek so se pripravili tudi slovenski astronomi. Meteorji predstavljajo za amatersko astronomijo pravo poslastico. Roj je namreč mogoče oceniti le s pomočjo vizualnih opazovanj (brez binokularjev ali celo teleskopov), poklicni astronomi pa tega ne počnejo. Ure in ure ležanja na prostem in 'štetje zvezd' je torej prepuščeno amaterjem, ki tako dobijo priložnost za dokaj resno astronomijo brez zelo drage opreme.

Napovedi povečane aktivnosti so jih torej samo še bolj spodbudile, na Javornik pa so privabile tudi mnogo neastronomov, ki so se ves teden obiskovali observatorij.

Vreme jim je bilo lani naklonjeno, prav tako tudi Luna. Opazili so 1519 meteorjev, preko 30 so jih posneli na video trak in okrog 20 je bilo ujetih v fotografski aparat. Res so opazili več meteorjev kot prejšnja leta, vendar jih je sredi najlepšega spektakla na višku meteorskega roja presenetilo jutro. Ker v Ameriki ob tistem času še ni bilo prave noči, je pravo predstavo videl morda le kakšen romantičen mornar sredi Atlantika. Rahlo razočarani so upali, da se sled za kometom v enem letu ne bo toliko razredčila, da ne bi mogli tudi naslednje leto videti kaj podobnega.

Zato smo tudi letos organizirali PAMET (Poletni Astronomski MEteorski Tabor), ki se je začel 8. avgusta. Spodbujeni z lanskimi rezultati (in spomini na jasne noči), smo se oborožili z dobro voljo, spalnimi vrečami, fotoaparati in celó videokamero. Ni nas potrla niti vremenska napoved niti dejstvo, da bo tokrat višek viden v Ameriki. Eno postojanko smo se namenili postaviti celo na Krvavec.

Vreme je bilo dejansko zelo slabo; doživeli smo tudi nekaj pravih hribovskih neviht. Ker pa smo bili stalno v pripravljenosti, smo ob vsaki še tako bledi in negotovi razjasnitvi hiteli postavljati stative, propeler (propeler, ki ga je izdelal Niko štritof, z vrtenjem nad fotoparatom prekinja ekspozicijo, tako da dobimo na filmu prekinjen meteor — ker poznamo hitrost vrtenja propelerja, lahko izračunamo kotno hitrost meteorja), ležalnike in videokamero. Izkoristili smo vse jasne trenutke in šele popolna oblačnost nas je prepričala, da smo vso opremo spet znosili nazaj in čakali naprej.

---

[1]Ponatisnjeno s prijaznim dovoljenjem uredništva revije Spika

Slika 1: Nekateri udeleženci tabora PAMET'94.

Vizualci so nekako uspeli zbrati dovolj podatkov za izračun ZHRa (Zenital Hourly Rate), ki je standardizirano merilo za pogostost meteorjev. Ta številka predstavlja število meteorjev, ki bi jih videli v eni uri, če bi gledali v zenit, videli zvezde do magnitude 6^m5 ter bi imeli popolnoma jasno nebo (torej brez oblačnosti in megle). Ta številka je sicer približna, in pri zelo drugačnih pogojih lahko dobimo precejšnja odstopanja, vendar pa je edino merilo za primerjavo.

Vsako noč se je, vsaj za nekaj trenutkov, nebo milostno prikazalo izza oblakov, tako da zbrani podatki lahko lepo prikažejo postopno naraščanje števila meteorjev. Najlepše je to razvidno iz diagrama ZHR (Slika 3), kjer so bili uporabljeni tudi podatki s prejšnjega, splošnega srednješolskega tabora '94. Pika predstavlja srednjo vrednost ZHR, črta pa odstopanje. Najvišja točka v bistvu predstavlja klasični maksimum, oziroma že upadanje aktivnosti, katere maksimum se je zgodil čez dan 12. avgusta. Na žalost se je nebo skoraj vsako noč pooblačilo kmalu po polnoči, pravi čas za meteorje pa je prav v drugem delu noči. Do polnoči namreč drobci 'dohitevajo' Zemljo, po polnoči pa jih Zemlja prestreza. Kljub vsemu smo letos na Javorniku opazili 324 meteorjev, od tega 215 Perzeidov. Podatke smo takoj poslali Mednarodni Meteorski Organizaciji (IMO). S pomočjo Mobitela smo jih sporočali v dolino, od tam pa preko elektronske pošte naprej v Belgijo. Fotografirati nam je uspelo 3 meteorje, od tega enega 'skozi' propeler (Slika 5) . Le-ta je Akvarid. Na ostalih fotografijah so en Perzeid (Sliki 0 in 8) in še en Akvarid (Sliki 6 in 7). Dva meteorja je na videokamero posnel Igor Grom kar iz Ljubljane, saj zaradi slabega vremena ni vzpostavil postojanke na Krvavcu. Videokamera na Javorniku je tokrat snemala v prazno. Filme smo lahko razvijali sproti, saj smo si kar v observatoriju uredili temnico.

Naši (evropski) in ameriški podatki dajo celotno sliko dogajanja, ki pa je, kljub še vedno precej povečani aktivnosti, razočaralo tiste, ki so si obetali vsaj tako predstavo kot lani. Zdaj se je upanje, da se bo le-to nadaljevalo še kakšno leto, povsem razblinilo. Vendar smo lahko prepričani, da bomo tudi naslednje leto slovenski astronomi opazovali z enako vnemo, kajti prav vsi meteroji, 'veliki' ali 'mali', nam za trenutek približajo vesolje.

Ursa Minor

Slika 2:Kljub slabemu vremenu nam ni bilo dolgčas.

Kaj se je v resnici zgodilo?

Pripravljeni smo bili na vse! O našem optimizmu pričajo tudi interna navodila, ki smo jih izoblikovali v pričakovanju gromozanskega števila meteorjev:

NAVODILA (interna)

VIZUALNO

- pari: 1 opazovalec + 1 zapisnikar
- če se aktivnost povečuje
  - najpomembnejši podatek je magnituda (poleg pripadnosti roju)
  - pišeš samo čas in magnitudo (poleg pripadnosti roju)
  - ko ne moreš več pisati časa
    - + pišeš samo pripadnost roju in magnitudo
    - + na vsakih 10–15 minut potegneš v formularju črto in označiš čas

FOTOGRAFSKO

50 mm:

- usmeritev proti radiantu
- vodenje
- expozicija $\geq$ 20 min
- rahlo zapri zaslonko

propeler:

- 50 mm, azimut 180° od radianta, center 60° nad obzorjem
- 20 mm, azimut 180° od radianta, spodnji rob videga polja 10° –20° nad obzorjem (Pazi na tržaške luči!)

VIDEO

- 12 mm objektiv
- usmeritev nad Ljubljano

Koliko smo opazovali in koliko videli, pove naslednja Tabelica:

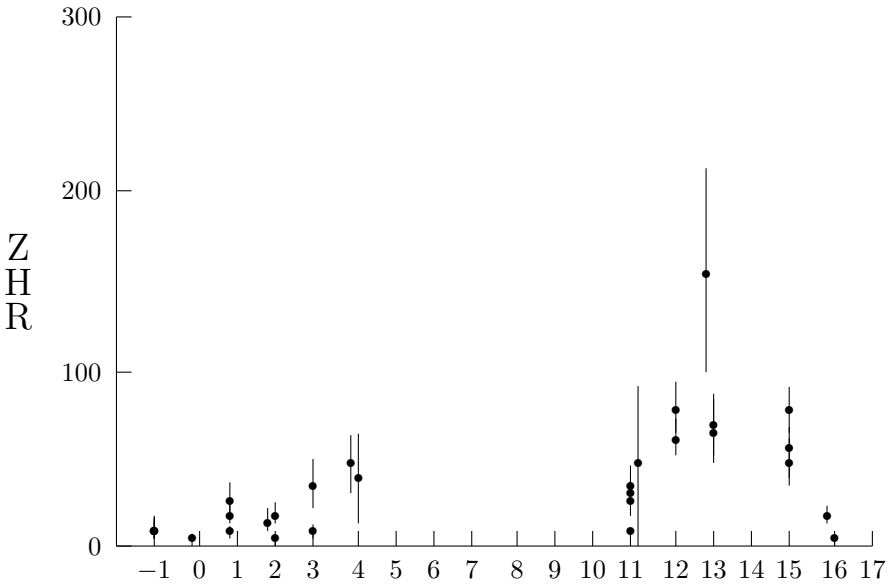
Opazovalna metoda	Skupen čas opazovanja	Število zaznanih meteorjev	Število Perzeidov
vizualno	30.4^{h}	557 (233+324)	272 (57+215)
fotografsko	13^{h}(61 posn.)	3	1
video	13.5^{h}	2	1

Fotografije v temle poročilu so delo fotografske skupine, video posnetke meteorjev si lahko ogledate pri Igorju Gromu, glavni rezultat vizualne skupine pa je bil diagram ZHR, ki ga predstavljamo v naslednjem razdelku.

ZHR

ZHR (Zenital Hourly Rate) je standardizirana mera za aktivnost meteorskega roja in pove, koliko meteorjev bi videli, ako bi imeli nebo brez oblačka, radiant v zenitu in mejno magnitudo 6^m5. Več o ZHR in njegovem izračunu si lahko ogledate v [1] in [2].

Navzlic relativno majhnemu številu opazovanj smo izračunali ZHR za vsak opazovalni interval. Opazovanja smo združili z opazovanji skupine za Sončev sistem poletnega raziskovalnega tabora ADJ. Rezultati izračunov so podani v Prilogi C, graf ZHR na Sliki 3 pa nam lepo pokaže postopno naraščanje aktivnosti Perzeidov in upad le-te po maksimumu.



Slika 3: ZHR Perzeidov v obdobju od 30. julija do 16. avgusta 1994.[1]

Komentar rezultatov vizualne skupine

Napovedi IMO so se izkazale za pravilne — maksimum aktivnosti so doživeli Američani. Bolje rečeno "v Ameriki", kajti skupina opazovalcev IMO se je prav za to priložnost napotila v ZDA, na mejo med Nevado in Kalifornijo, kjer so opazovali v odličnih pogojih — mejna magnituda boljša kot 6^m5.

Tudi opazovalci Astronomskega društva Javornik smo svojo nalogo opravili odlično. Nismo sicer mogli videti mlajšega maksimuma, smo pa ujeli tradicionalni maksimum. Napovedi so predvidevale maksimum 12. avgusta okrog 21^{h} UT. Pogled na Sliko 3, še bolj pa v Tabelo v Prilogi C, pa razkrije, da je bil po naših opazovanjih maksimum aktivnosti 12. avgusta v intervalu $21^{\mathrm{h}}13^{\mathrm{m}}$ – $21^{\mathrm{h}}40^{\mathrm{m}}$, centriranem okrog $21^{\mathrm{h}}26^{\mathrm{m}}$. V tem intervalu smo izmerili ZHR 154 ± 58, kar je popolnoma v skladu s Perzidi, kakršne poznamo že vrsto let.

Naj poudarim, da smo ena izmed redkih Evropskih opazovalnih skupin, ki je letos uspela opazovati Perzeide, kar zgovorno potrjuje tudi izjava Rainerja Arlta, vodje vizualne sekcije IMO:

[1] Pri izračunu smo upoštevali $r = 2$

```
From: NAME: Rainer Arlt
FUNC: compuserve <100114 1361@5=COMPUSERVE@3=COM@2=D400@1=DE@X400@STENAR>
To:   NAME: Aram Karalic
FUNC: ijs <ARAM@CATHY@MRGATE@STENAR>

Dear Aram,
Thank you very much for the Perseid reports.  I've seen the large cloud factors in the
night August 12-13.  Was weather that terrible?
I just received the data of the Belgian observers.  They were not able to watch after
August 10.  I guess, there will be not that much Perseid stuff this year compared to 1993.
Best wishes, Rainer.
```

Slika 4: Sponzorji so nam obilno napolnili hladilnik...

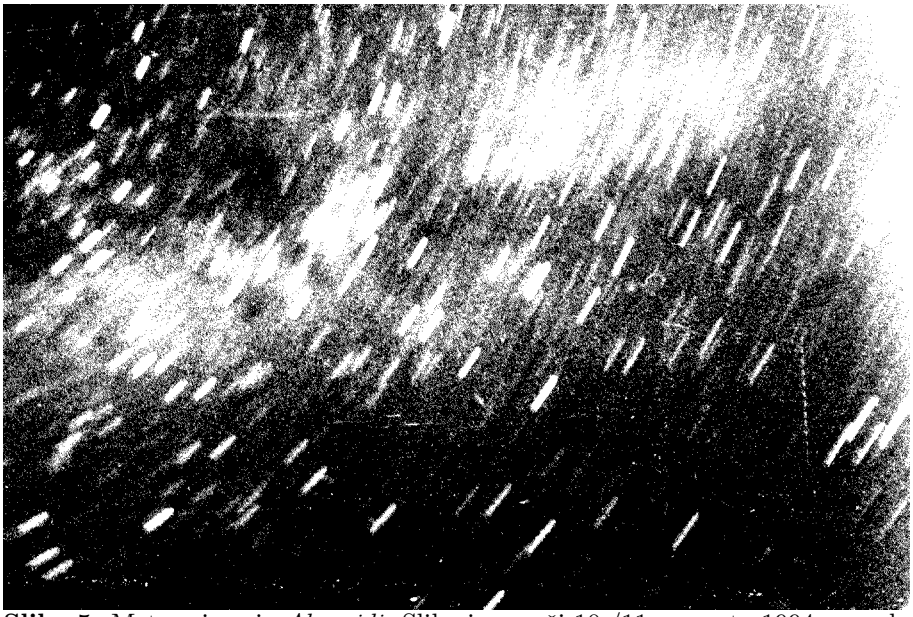
Fotografsko opazovanje

Fotografija je še bolj občutljiva na slabo vreme oziroma oblake, ki se podijo po nebu med ekspozicijo, zato je treba resnično pohvaliti prizadevnost fotografske skupine.

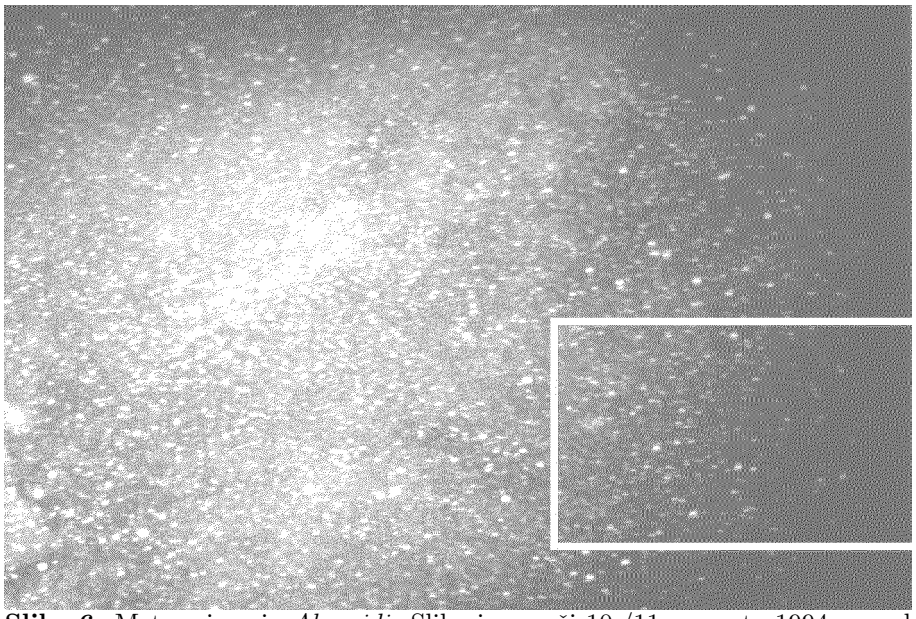
Že vizualci smo opazili precej meteorjev iz drugih rojev — Cygnidov in Akvaridov. Fotografi so naša opazovanja dodatno potrdili: posneli so namreč enega Perzeida (Sliki 0 in 8) in dva Akvarida (Slike 5, 6 in 7).

Fotografska skupina je posnela 61 fotografij s skupnim trajanjem 13.5^{h}, snemali pa so na visoko občutljive na filme Kodak TMax 3200.

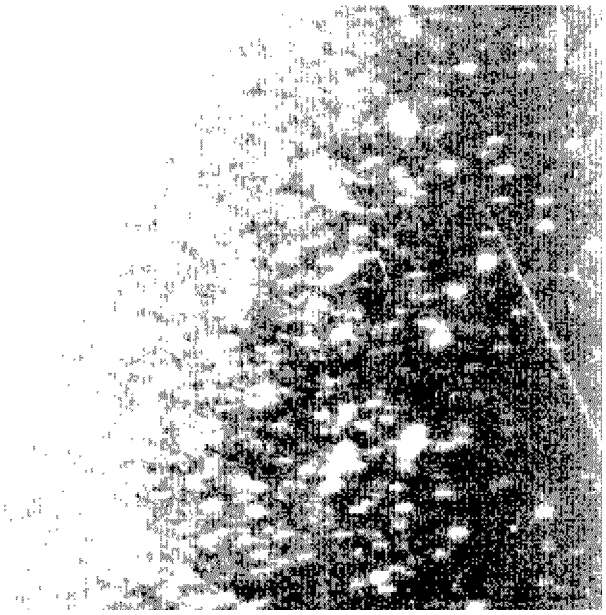
Posebno ponosni smo na Sliko 5, saj je bila narejena skozi "propeler". Propeler je imel 4 krake in se je zavrtel 375 × v minuti. Se pravi, da so se prekinitve vrstile na 1/25 s. Meteor na sliki ima 12 prekinitev, kar pomeni, da je trajal 0.5 s.



Slika 5: Meteor iz roja *Akvaridi*. Sliko je v noči 10./11. avgusta 1994 posnela Janja Plazar na Javorniku. Objektiv: 20 mm $f/2.8$, film: Kodak TMax 3200. Prekinitev slike 25 × na sekundo.



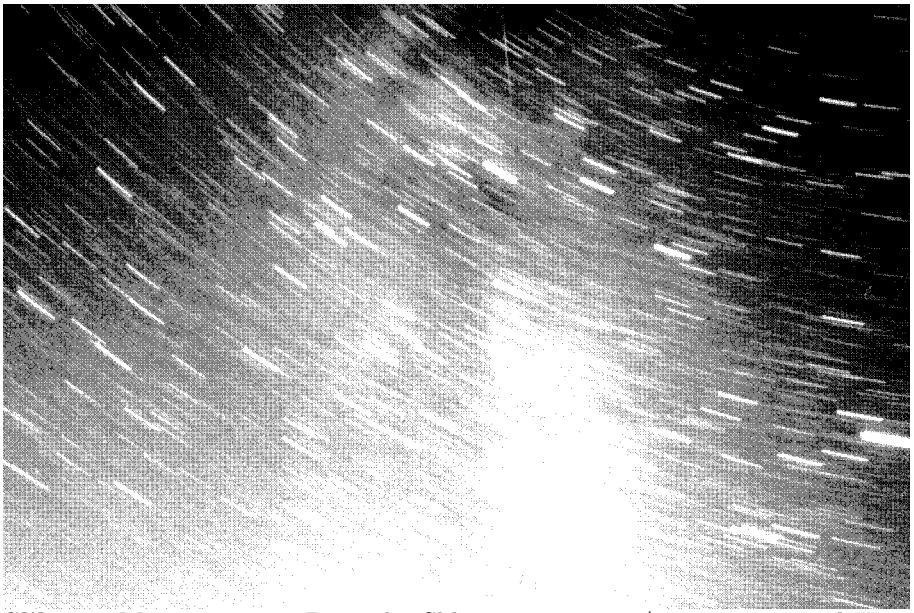
Slika 6: Meteor iz roja *Akvaridi*. Sliko je v noči 10./11. avgusta 1994 posnel Robert Terčelj-Schweizer na Javorniku. Objektiv: 50 mm $f/1.8$, film: Kodak TMax 3200, ekspozicija od $22^{\mathrm{h}}43^{\mathrm{m}}$ UT do $23^{\mathrm{h}}03^{\mathrm{m}}$ UT. Meteor se nahaja v belo obrobljenem pravokotniku. Povečan pravokotnik je na Sliki 7.



Slika 7: Povečan in dodatno računalniško obdelan izsek Slike 6.

Opazovanje z videokamero

Tudi letos smo meteorje snemali z občutljivo videokamero (0.3 lux), z 12 mm objektivom. Vidno polje te kamere je približno tako kot vidno polje 24 mm × 36 mm fotoaparata s 50 mm objektivom, kamera pa zazna zvezde do 3^m. Vendar pa je video opazovanje še bolj občutljivo na vreme kot fotografsko. Kljub temu pa je letos kamera med skupnim časom snemanja 13.5^{h} ujela dva meteorja in sicer ne na Javorniku, kjer smo snemali skupno 4.5^{h}, ampak v Ljubljani, od koder je 9^{h} snemal Igor Grom.



Slika 8: Meteor iz roja *Perzeidi*. Sliko je v noči 14./15.8.1994 posnel Uroš Čotar na Javorniku. Objektiv: 20 mm $f/3.5$, film: Kodak TMax 3200, ekspozicija od $23^{\mathrm{h}}55^{\mathrm{m}}$ do $00^{\mathrm{h}}05^{\mathrm{m}}$ UT.

Kaj lahko pričakujemo naslednje leto?

Oba vrhunca lahko pričakujemo med 12. avgustom 1995 ob 13^{h}UT in 13. avgustom 4^{h} UT. Na žalost bo leta 1995 Luna precej motila opazovanja, saj bo prav takrat skoraj polna in nam bo svetila vso noč:

D A T U M	L U N A			S O N C E	
	vzide	zaide	faza	vzide	zaide
10. 8. 1995	$18^{\mathrm{h}}\,{}^{3}/_{4}$	$4^{\mathrm{h}}\,{}^{1}/_{2}$	1.00	5^{h}	$19^{\mathrm{h}}\,{}^{1}/_{4}$
11. 8. 1995	$19^{\mathrm{h}}\,{}^{1}/_{4}$	$5^{\mathrm{h}}\,{}^{3}/_{4}$	0.99	5^{h}	$19^{\mathrm{h}}\,{}^{1}/_{4}$
12. 8. 1995	$19^{\mathrm{h}}\,{}^{3}/_{4}$	7^{h}	0.96	5^{h}	$19^{\mathrm{h}}\,{}^{1}/_{4}$
13. 8. 1995	$20^{\mathrm{h}}\,{}^{1}/_{4}$	8^{h}	0.91	5^{h}	19^{h}
14. 8. 1995	$20^{\mathrm{h}}\,{}^{3}/_{4}$	$9^{\mathrm{h}}\,{}^{1}/_{4}$	0.83	5^{h}	19^{h}
15. 8. 1995	$21^{\mathrm{h}}\,{}^{3}/_{4}$	$10^{\mathrm{h}}\,{}^{1}/_{4}$	0.75	5^{h}	19^{h}

Priloga A: IMO Press Release

Press release from the International Meteor Organization

Unusually high meteor activity on August 11-12?

Contact addresses are given at the end.

Astronomers predict possibility of unusually high meteor activity on the night of August 11-12, 1994, especially for observers in North America. If the prediction proves to be true both astronomers and the general public might be treated to a spectacular rain of shooting stars. If actually occurring, the event can be easily observed with the naked eye.

The *International Meteor Organization* wishes to alert the public that this year's return of the Perseid meteor shower may be particularly dramatic for North America. The possibility that sky-watchers will be treated to a spectacular celestial pyrotechnics show in August during the annual Perseid meteor shower is high since the displays during the past 3 years have shown much higher than normal activity. Normally, every year around August 12, night watchers can see up to 80 meteors an hour from the shower which is known as the *Perseids* as the meteors radiate from the constellation Perseus. This is the most watched annual meteor event in the northern hemisphere.

An attentive watcher may see up to 15 shooting stars per hour in dark skies during any clear, dark, moonless night. On a few nights of the year, however, more meteors than usual will be seen as the Earth crosses through the orbit of a meteoroid stream. The shooting stars or meteors are the luminous phenomena produced by meteoroids when they enter the Earth's upper atmosphere at high speeds.

The meteors associated with the Perseid shower are derived from the dust emitted by Comet Swift-Tuttle as it moves in its orbit about the Sun. Since Swift-Tuttle passed through the inner Solar System late in 1992, material recently ejected from the comet is still present along its orbit.

The first indications that the Perseid stream might produce something unusual this year were found in 1988 and 1989 in the form of slightly increased Perseid activity. In 1991, the shower produced a rate of many hundreds of meteors per hour for about an hour for Japanese stargazers, while an even more spectacular display was observed in Asia and Eastern Europe in 1992. In 1993, the shower was particularly intense from Europe, showing activity about 3 times stronger than normal on the night of August 11. Interference from moonlight hampered the full glory of the show from many locations in 1993, particularly in North America. Astronomers expect that the 1994 display will be similiar in intensity to that of 1993 and will occur at a time of the night favoring North America, particularly the western part of the continent.

The encounter geometry in 1994 suggests that meteor activity will be at its climax between 8^h00^m and 12^h00^m Universal Time (which is between 4 a.m. and 8 a.m. EDT, and between 1 a.m. and 5 a.m. PDT) in the night of August 11-12, 1994. The exact time is also somewhat uncertain; strong activity could occur as much as 6 hours on either side of this time. The shower will also be apparent, though not as strong, on the nights of August 9, 10, 12, and 13. The best period to watch the shower on these nights is from midnight until dawn local time, though because of the point in the sky where the meteors appear to radiate from the best latitudes are temperate northern latitudes. The shower can be seen anywhere North of 30° South, but North of the equator is best.

Background information:

Meteoroids are small bodies that populate the Solar System. They vary from micrometer-sized dust particles of low-density that are debris from the decay of comets, to solid chunks of rock meters across that come from broken-up minor planets. Comets, such as Comet Halley, leave behind belts of meteoroidal debris along their orbit after being heated by the Sun and emitting gases which drag the meteoroidal particles off the comet. These belts may become meteor showers on the Earth if the Earth encounters this stream of debris. All the planets and their satellites are continuously bombarded by meteoroids which either evaporate in the atmospheres or hit the surface and create craters, the same process which formed the craters on the lunar surface.

Most Perseid meteors totally evaporate in the Earth's atmosphere at heights around 100 km. Scientists believe that cometary meteoroids (such as the Perseids) are not structurally strong enough to survive atmospheric flight and so they cannot reach the surface of the earth as a meteorite. Perseid meteoroids enter the atmosphere at 60 km/s. The parent comet, Swift-Tuttle, orbits the sun every 135 years. A Perseid meteor that is roughly as bright as the brightest stars, results from a meteoroid that is only a few milligrams in mass. During the meteor storm of 1966, which was associated with a meteor shower called the Leonids, meteor activity reached 40 meteors per second. While such activity is not likely to be associated with the 1994 Perseids, meteor rates approaching 1 Perseid every 10 seconds are possible.

Suggested references for further background information:

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Priloga B: Bilteni IMO

I N T E R N A T I O N A L M E T E O R O R G A N I Z A T I O N

1994 PERSEID BULLETIN #1
ISSUED 16UT, AUGUST 12, 1994

SUMMARY:

Perseid ZHR's were normal from Aug 11.88 UT - Aug 12.40 UT being in the range ~50-100. Starting at ~Aug 12.40 the ZHR began climbing significantly and reached a peak in the 250-300 range in the 0.5 hour interval centred about Aug 12.45 UT. The ZHR dropped back to normal levels of ~50-100 by Aug 12.50 UT. No results after Aug 12.50 UT are yet avaliable. The above summary relies heavily on the single group of experienced observers near Reno, Nevada and we caution drawing any final conclusions about activity until other groups observing in this interval have reported their observations.

DETAILS:

Preliminary results from observers indicate that an outburst of the Perseids has occurred again this year, centred about Aug 12.45 UT with a maximum ZHR of ~250-300. The basis for this report comes from J. Rendtel, I. Rendtel, A. Knoefel and D. Holman who observed the display from the Nevada-California border NE of Reno, Nevada under excellent sky conditions (limiting magnitude better than 6.5). Beginning at Aug 12.18 UT the group recorded ZHR's of ~50 with this value increasing steadily throughout the night reaching ~100-120 by Aug 12.39. The ZHR peaked in the interval Aug 12.44-12.46 with an estimated peak ZHR of 250-300. At least 5 fireballs were reported by the group during this 0.5 hour interval. The ZHR showed a steep decline from Aug 12.46-12.48 ending at a value of ~50-80 by Aug 12.48 UT. Rendtel commented on strong fluctuations in activity during the Aug 12.46-12.48 interval.
This picture is supported generally by observations made in other parts of North America.
B. Lunsford (Chula Vista, California, USA) reports generally cloudy conditions with only 0.5 hours of clear observing centred about Aug 12.49 with a ZHR~100 under 6.3 Lm skies.
R. Huziak (Saskatoon, Saskatchewan, Canada) reports a ZHR~90 under good conditions (Lm=6.0) centred around the hour of Aug 12.38. He notes that the rates were climbing all evening and reached this maximum just before twilight. He also comments that the shower seemed to be a 'normal' rate or below 'normal' rate shower during these intervals.
R. Taibi (McKendry, Viriginia, USA) observed under much less favourable conditions with extensive cloud and light pollution. His most favourable hour under Lm=~4.5 centred about Aug 12.36 resulted in a ZHR~70, though correction from the raw rate exceeded a factor of 5 and hence large errors are possible. Taibi commented that the number of fireballs was picking up towards end of observations at Aug 12.38 UT.
T. Dickinson (Yarker, Ontario, Canada) recorded a peak ZHR of ~70 under excellent conditions with Lm=6.4 in the hour centred about Aug 12.34 before twilight interfered. He noted few bright meteors in this interval.
P. Gray (Halifax, Nova Scotia, Canada) reports observations under Lm=5.5 from a group of 9 observers whose individual ZHR's fell in the range 70-160 centred about Aug 12.27.
N. McLeod III (Ft. Myers, Florida, USA) reports a ZHR~30 centred about Aug 12.25 and notes that in casual observing through partly cloudy skies no significantly high activity was obvious up to Aug 12.40 UT.
T. Hillestad (Kongsberg, Norway) reports that he and L. Heen had the

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impression that rates picked up near Aug 12.00 UT with a fair number of
bright meteors. Hillestad also notes that he felt rates were high the
entire time, but particularly so after Aug 12.00 UT.
G. Zajacz (Debrecen, Hungary) report that ZHR's were ~50 in the interval
Aug 11.88-11.92 UT and showed no unusual number of bright members.
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I N T E R N A T I O N A L M E T E O R O R G A N I Z A T I O N

1994 PERSEID BULLETIN #2
ISSUED 20UT, AUGUST 13, 1994

SUMMARY:

Perseid ZHR's were normal from Aug 11.88 UT - Aug 12.30 UT being in the range ~50-100. Starting at Aug 12.35 the ZHR began climbing significantly and reached a peak near 250 in the 0.5 hour interval centred about Aug 12.45 UT. The results from the single group at Honey Lake, California reporting detailed quantitative data are supported by qualitative data from more casual observers on the West coast. The ZHR dropped back to normal levels of ~50-100 by Aug 12.50 UT. No results immediately after Aug 12.50 UT are yet avaliable. The shower had returned to normal activity levels by Aug 12.88 based on European data from Austria and the U.K. Radio results support a peak near Aug 12.45 with higher rates from Aug 12.35-12.47.

DETAILS:

J. Rendtel, I. Rendtel, A. Knoefel and D. Holman (Honey Lake, California) have reported more details concerning their observation of the outburst near Aug 12.45 UT (solar longitude 139.58 (2000.0)). The following table lists the average ZHR's derived from their observations centred about the given UT times:

DATE (UT)	ZHR
Aug 12.21	50
Aug 12.25	60
Aug 12.29	60
Aug 12.33	70
Aug 12.38	110
Aug 12.42	180
Aug 12.45	225
Aug 12.48	150
Aug 12.50	80

The observers suggest that the rising flank of the outburst began near Aug 12.35 UT (0830 UT) and was over by Aug 12.5 (1200 UT).
Peak time is essentially the same as derived in Bulletin #1 as Aug 12.45 (1030-1100 UT), but the peak ZHR (derived from the 15 minute interval from 1045-1100) is 225, slightly lower than previously reported, however, still in agreement within error margins. Shorter intervals (~5 minutes) between 1030-1100 UT easily lead to equivalent ZHR's near 400-500.
Fireballs observed by the group:

Time (UT) Interval	Number of fireballs
0338	1
0338-0900	3
0900-1000	5
1000-1100	7
1100-1130	2

T. Wright (Marin County, California) qualitatively reports intense activity from 1000-1100 UT, August 12 (Aug 12.42-Aug 12.46).

D. Chamberlin (Mt. Hood, Oregon) qualitatively reports a strong maximum reached at 1045 UT, August 12 (Aug 12.45) with a visual rate of 3-4/minute.

G. Elmore (Santa Rosa, California) reports that a group of 3 observing

different sects of the sky began observing at 1045 UT and recorded
a peak rate of 39/minute near 1045 UT, August 12 (Aug 12.45)
which tapered to 5/minute for the group of 3 observers by 1100 UT (Aug 12.46).
Compared the display to what he had seen visually during the 1966 Leonids.

J. Paulson (Mary's Peak, Oregon) qualitatively estimated a peak rate
of 3-4/minute in the interval 1045-1130 UT, August 12 (Aug 12.45-12.48).

C. Tribolet (Morgan Hill, California) reports peak rate higher than seen
last year in California with Lm=6 he estimates peak observed rate of 60/hr
for a half-hour interval in the range 0900-1100 UT, August 12 (Aug 12.38-12.46).

M. Smithwick (San Francisco, California) qualitatively estimates between
80-100 meteors between 1030-1130 UT (Aug 12.44-12.48) under urban skies.

B. Templeton (Freemont Peak State Park, California) qualitatively reports
group observations suggesting peak period of activity from 1030-1130 UT,
August 12 (Aug 12.44-Aug 12.48) with several minutes of activity where
a meteor was visible every 2-3 seconds.

R. Hawkes (Sackville, New Brunswick, Canada) running MCP-CCD video
intensified system to Lm=+8.5 from 0115-0830 UT, August 12 (Aug 12.05-12.35)
reports no spectacular rates at low magnitudes and rates below 1993
numbers at corresponding times.

C. Steyaert (Belgium) reports that M. De Meyere (Deurle, Belgium)
recorded relative maximum radio forward scatter rates between 1000-1100 UT on
August 12 (Aug 12.44) with rates corresponding to 3.5 times similar
level of activity the previous night. Broad maximum in rates between
0800-1200 UT, August 12 (Aug 12.33-12.5).

R. Royer (Bishop, California) observed in group of 11 and qualitatively
notes that few meteors were seen before 0900 UT, August 12 (Aug 12.38).
After 0900 UT, rates began picking up. Combined four observer rate
(covering different quadrants of the sky) from 1100-1105 UT - 38 Perseids,
from 1130-1135 UT - 22 Perseids. Many fireballs were observed up to
magnitude -9.

S. Ennis (Elizabethtown, Kentucky) reports that radio observations on the
morning of August 12 at 144 Mhz were generally poor. Most intense flurries
of activity heard between 1048-1118 UT, August 12 (Aug 12.45-12.47).

D. Swann (Oklahoma) reports that activity was generally quiet August 12
before 0830 UT. After 0830 UT (Aug 12.35), some increase in rates were
noticed until twilight ended observations.

M. Hann (Mounds, Oklahoma) recorded ZHR's ~90-100 in the interval
0830-1030 UT (Aug 12.35-12.44) with twilight strongly interfering in
the last hour. A gradual increase in rates from 0430 UT (ZHR ~ 50)
to 0830 UT (ZHR ~90) was noted.

P. Strosser (Sierra Nevada Mountains, California) qualitatively reports
a strong outburst observed under excellent sky conditions. Approximate
ZHR's reported from 0600-0800 UT ~40, from 0800-0900 UT ~100 and
from 0900-1100 UT ~600-700. Numerous fireballs were recorded in this time.

P. Jenniskens (California) reports a peak visual rate of 3/minute was
reached at 1110 UT (Aug 12.47).

Priloga C: Tabela z izračuni ZHR

Datum	Interval (UT)	Sredina	Lm	h	F	C	K	$Teff$	N	ZHR
29.07.1994	$21^h21^m-22^h21^m$	21^h51^m	5^m5	28°	1.00	2.00	2.13	1.00	2	9 ± 6
29.07.1994	$21^h20^m-22^h32^m$	21^h56^m	6^m0	29°	1.00	1.41	2.06	1.20	3	7 ± 4
29.07.1994	$22^h38^m-23^h47^m$	23^h12^m	5^m2	37°	1.00	2.46	1.66	1.03	2	8 ± 6
29.07.1994	$22^h58^m-23^h53^m$	23^h26^m	5^m4	38°	1.00	2.14	1.62	0.90	2	8 ± 5
30.07.1994	$21^h22^m-22^h28^m$	21^h55^m	5^m7	29°	1.00	1.74	2.06	1.10	1	3 ± 3
31.07.1994	$20^h38^m-21^h38^m$	21^h08^m	5^m9	25°	1.00	1.52	2.37	1.00	7	25 ± 9
31.07.1994	$20^h49^m-21^h46^m$	21^h18^m	6^m3	26°	1.00	1.15	2.28	0.95	6	17 ± 7
31.07.1994	$21^h48^m-22^h54^m$	22^h21^m	6^m2	32°	1.00	1.23	1.89	1.10	3	6 ± 4
01.08.1994	$20^h55^m-21^h55^m$	21^h25^m	6^m0	27°	1.00	1.41	2.20	1.00	4	12 ± 6
01.08.1994	$21^h01^m-22^h09^m$	21^h35^m	5^m9	28°	1.00	1.54	2.13	1.13	1	3 ± 3
01.08.1994	$22^h03^m-23^h28^m$	22^h45^m	6^m0	35°	1.00	1.41	1.74	1.07	7	16 ± 6
02.08.1994	$20^h19^m-21^h27^m$	20^h53^m	5^m2	25°	1.00	2.46	2.37	1.00	6	35 ± 14
02.08.1994	$20^h29^m-22^h48^m$	21^h38^m	5^m9	29°	1.00	1.52	2.06	1.55	4	8 ± 4
03.08.1994	$22^h23^m-23^h23^m$	22^h53^m	5^m3	37°	1.67	2.30	1.66	1.00	7	45 ± 17
03.08.1994	$23^h41^m-24^h00^m$	23^h50^m	5^m4	43°	1.82	2.14	1.47	0.32	2	36 ± 25
10.08.1994	$20^h45^m-21^h45^m$	21^h15^m	5^m5	29°	1.00	2.00	2.06	1.00	6	25 ± 10
10.08.1994	$21^h55^m-22^h55^m$	22^h25^m	5^m7	37°	1.00	1.74	1.66	1.00	12	35 ± 10
10.08.1994	$23^h26^m-24^h40^m$	24^h03^m	6^m3	48°	1.00	1.19	1.35	1.23	6	8 ± 3
10.08.1994	$23^h37^m-24^h52^m$	24^h15^m	6^m2	49°	1.02	1.23	1.33	1.25	22	29 ± 6
10.08.1994	$24^h48^m-24^h53^m$	24^h50^m	5^m4	54°	1.43	2.14	1.24	0.08	1	45 ± 45
11.08.1994	$24^h49^m-26^h28^m$	25^h38^m	5^m7	60°	1.52	1.74	1.15	1.08	27	76 ± 15
11.08.1994	$24^h49^m-26^h31^m$	25^h40^m	6^m2	60°	1.53	1.27	1.15	1.30	35	61 ± 10
12.08.1994	$21^h13^m-21^h40^m$	21^h26^m	5^m7	31°	1.82	1.74	1.94	0.28	7	154 ± 58
12.08.1994	$25^h00^m-25^h49^m$	25^h25^m	6^m3	59°	2.80	1.19	1.17	0.82	14	66 ± 18
12.08.1994	$25^h02^m-25^h50^m$	25^h26^m	6^m3	59°	3.10	1.16	1.17	0.80	12	63 ± 18
14.08.1994	$22^h12^m-23^h12^m$	22^h42^m	5^m6	40°	1.28	1.87	1.56	1.00	13	48 ± 13
14.08.1994	$22^h38^m-24^h02^m$	23^h20^m	6^m4	45°	1.10	1.11	1.41	0.76	33	75 ± 13
14.08.1994	$23^h20^m-24^h16^m$	23^h48^m	5^m6	48°	1.41	1.88	1.35	0.93	14	54 ± 14
15.08.1994	$20^h36^m-24^h17^m$	22^h26^m	6^m3	39°	1.05	1.15	1.59	1.43	12	16 ± 5
15.08.1994	$23^h07^m-24^h07^m$	23^h37^m	5^m8	47°	1.30	1.62	1.37	1.00	1	3 ± 3

Tabela: Izračun ZHR.[2]

[2]Pri izračunu smo upoštevali $r = 2$

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Literatura

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