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IMO

Daytime Meteor Showers

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Outline

- Motivation
- Meteor shower radiants
General sources, known showers
- Current data
Activity level? Activity period? Shower parameter?
- Observing possibilities & proposal
- Conclusions

Motivation: why daytime showers?

Shower Calendar 2014

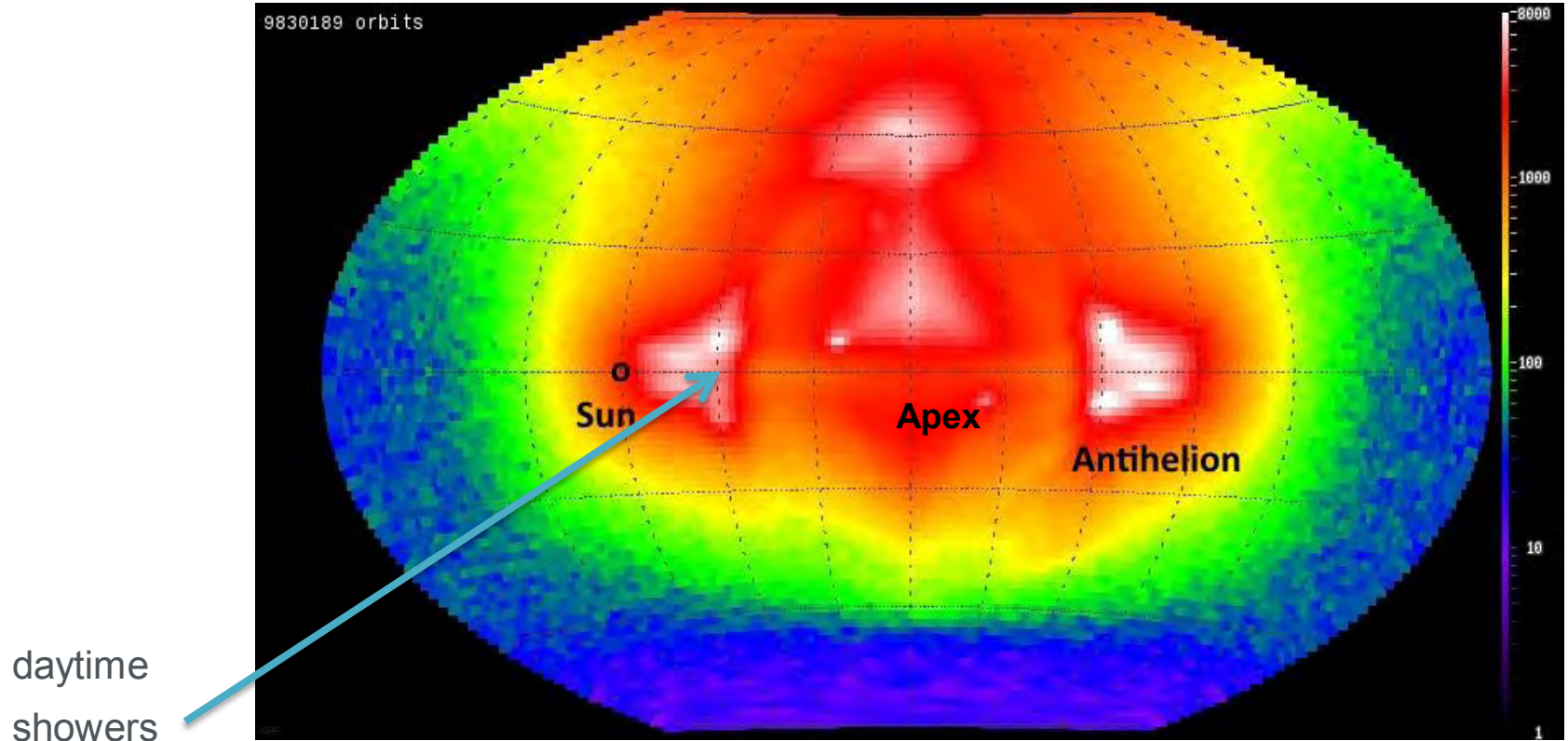
Shower	Activity	Max Date	λ_{\odot} 2000	Radiant		Best observed		Rate
				α	δ	50° N	35° S	
Cap/Sagittariids	Jan 13–Feb 04	Feb 01*	312°5	299°	−15°	11 ^h –14 ^h	09 ^h –14 ^h	Medium*
χ -Capricornids	Jan 29–Feb 28	Feb 13*	324°7	315°	−24°	10 ^h –13 ^h	08 ^h –15 ^h	Low*
Piscids (Apr)	Apr 08–Apr 29	Apr 20	30°3	7°	+07°	07 ^h –14 ^h	08 ^h –13 ^h	Low
δ -Piscids	Apr 24–Apr 24	Apr 24	34°2	11°	+12°	07 ^h –14 ^h	08 ^h –13 ^h	Low
ε -Arietids	Apr 24–May 27	May 09	48°7	44°	+21°	08 ^h –15 ^h	10 ^h –14 ^h	Low
Arietids (May)	May 04–Jun 06	May 16	55°5	37°	+18°	08 ^h –15 ^h	09 ^h –13 ^h	Low
σ -Cetids	May 05–Jun 02	May 20	59°3	28°	−04°	07 ^h –13 ^h	07 ^h –13 ^h	Medium*
Arietids	May 22–Jul 02	Jun 07*	76°7	44°	+24°	06 ^h –14 ^h	08 ^h –12 ^h	High
ζ -Perseids	May 20–Jul 05	Jun 09*	78°6	62°	+23°	07 ^h –15 ^h	09 ^h –13 ^h	High
β -Taurids	Jun 05–Jul 17	Jun 28	96°7	86°	+19°	08 ^h –15 ^h	09 ^h –13 ^h	Medium
γ -Leonids	Aug 14–Sep 12	Aug 25	152°2	155°	+20°	08 ^h –16 ^h	10 ^h –14 ^h	Low*
Sextantids	Sep 09–Oct 09	Sep 27*	184°3	152°	00°	06 ^h –12 ^h	06 ^h –13 ^h	Medium*

Discussion while preparing the 2015 Calendar:

- data stored in IAU MDC – which shower do we speak about?
- detection, activity level and periods uncertain
- profiles from radio (FS) and radar (BS) available?

Sources

... of sporadic meteors

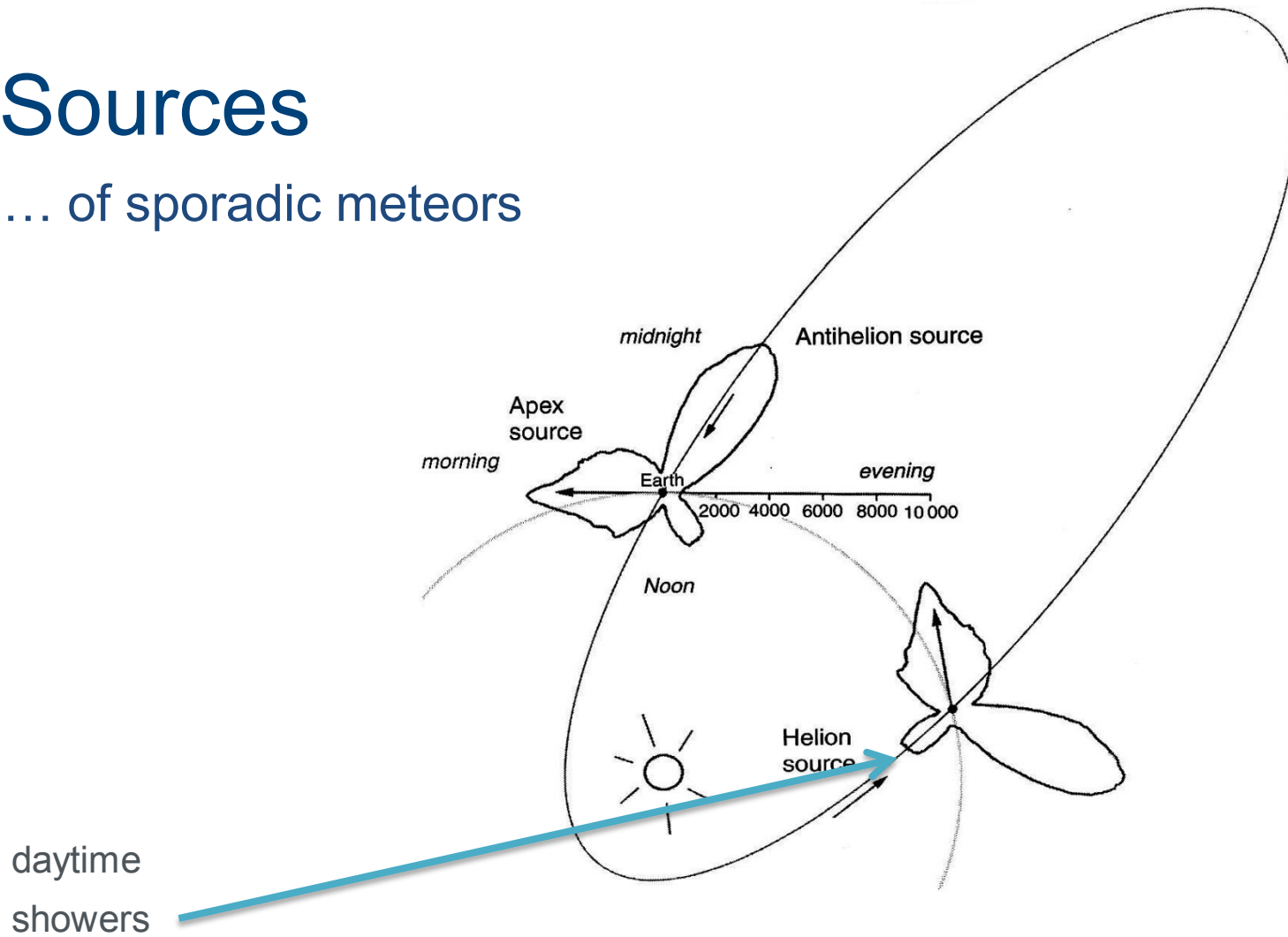


Approx. 70° east of Apex

CMOR radar observations, Campbell-Brown, 2004

Sources

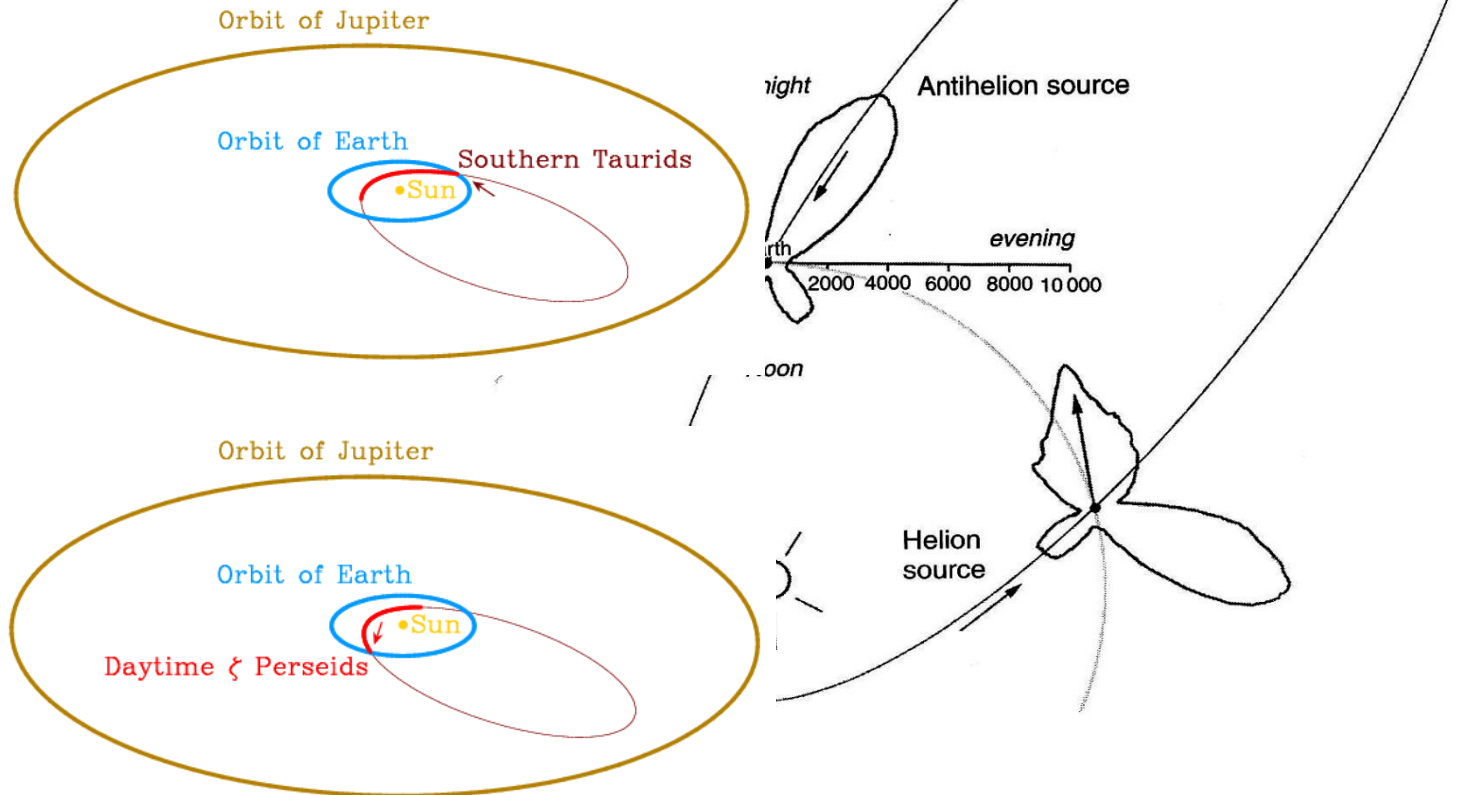
... of sporadic meteors



AMOR radar observations 1990-91, Baggaley

Sources

... ecliptical showers



Connection between branches of one stream (Asher, 2000)

Jupiter-family comets on Apollo-like orbits

V 11..45 km/s (peak \sim 20 km/s)

Known daytime showers

Data stored in IAU MDC

Most cases only original detection papers listed (1950s-1970s)

Example: 171 ARI

Clegg, Hughes, Lovell (1947)

Almond (1951) – orbits

Sekanina (1976)

Recent studies – based on radar data

Difference in meteoroid sizes: FS ~ visual/video, BS much smaller

Brown et al., 2008 ff. analyses of CMOR

Janches et al., 2013 – southern hemisphere SAAMER data

Campbell-Brown, 2004: ARI June 08, ZHR ~ 200, $r = 2.75$

Known daytime showers

Data stored in IAU MDC

Most cases only original detection papers listed (1950s-1970s)

Example: 171 ARI (Daytime Arietids)

Similarity Daytime Arietids – comets Marsden group

Marsden group – sunskirters, perihel 6-15 R \odot

complex of: Marsden group comets (~ 5.5 years orbital period)

96P/Machholz

Daytime Arietids (1.6-2.3 years period), δ Aquariids

(QUA + 2003EH1 ?)

(Kracht et al., 2002, Marsden 2004, Sekanina&Chodas 2005, Jenniskens 2012)

Known daytime showers

Data stored in IAU MDC

Most cases only original detection papers listed (1950s-1970s)

Example: 221 DSX (Daytime Sextantids)

Phaethon – Geminid – complex (Ohtsuka et al., 2006; Ryabova et al., 2014)

„medium activity“ – from Weiss (1960)

Recent data: Galligan & Baggaley (2002) – AMOR radar

Various peaks Sep 27-30,

probably over a longer period / extending into early October

Observing possibilities

Data stored in IAU MDC

Most radiant of daytime showers 5-25 deg west of the Sun

Largest elongations:

293 DCE (o Cetids) / 152 NOC (N ω Cetids) in May	31 / 38 deg
171 ARI (Arietids)	35 deg
221 DSX (Sextantids)	33 deg

171 ARI and 221 DSX – activity level medium-high (Cetids: low)

Promising for combined observations to calibrate methods

Next: some details

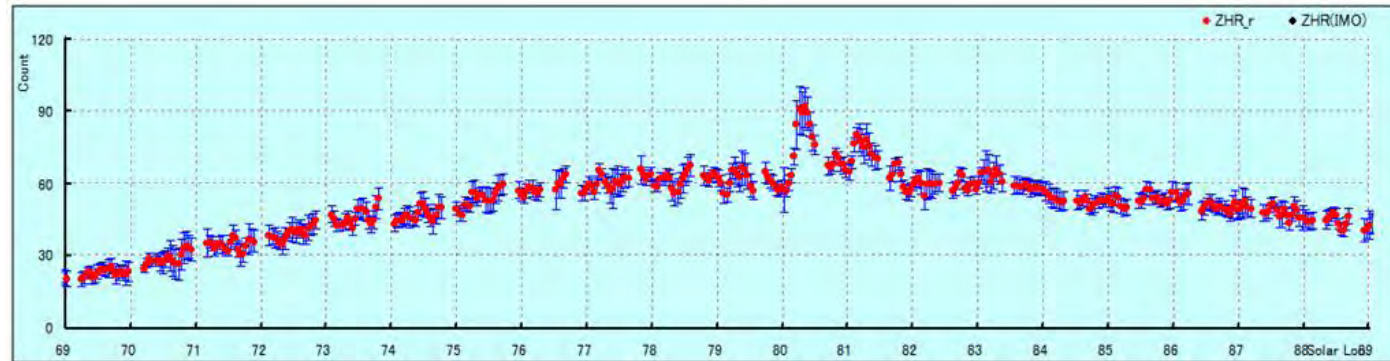
Observing possibilities

Radio and radar data

Analyses necessary

Sugimoto published profiles for major showers and some events

Example: ARI 2011



Optical data?

Few possibilities:

171 ARI early June

221 DSX end September

Problem: how much can be seen?

Observing possibilities

Optical data?

Analyses of EDMOND data (Rudawska et al., 2014) include **171 ARI**

(also Fujiwara 2004 video data)

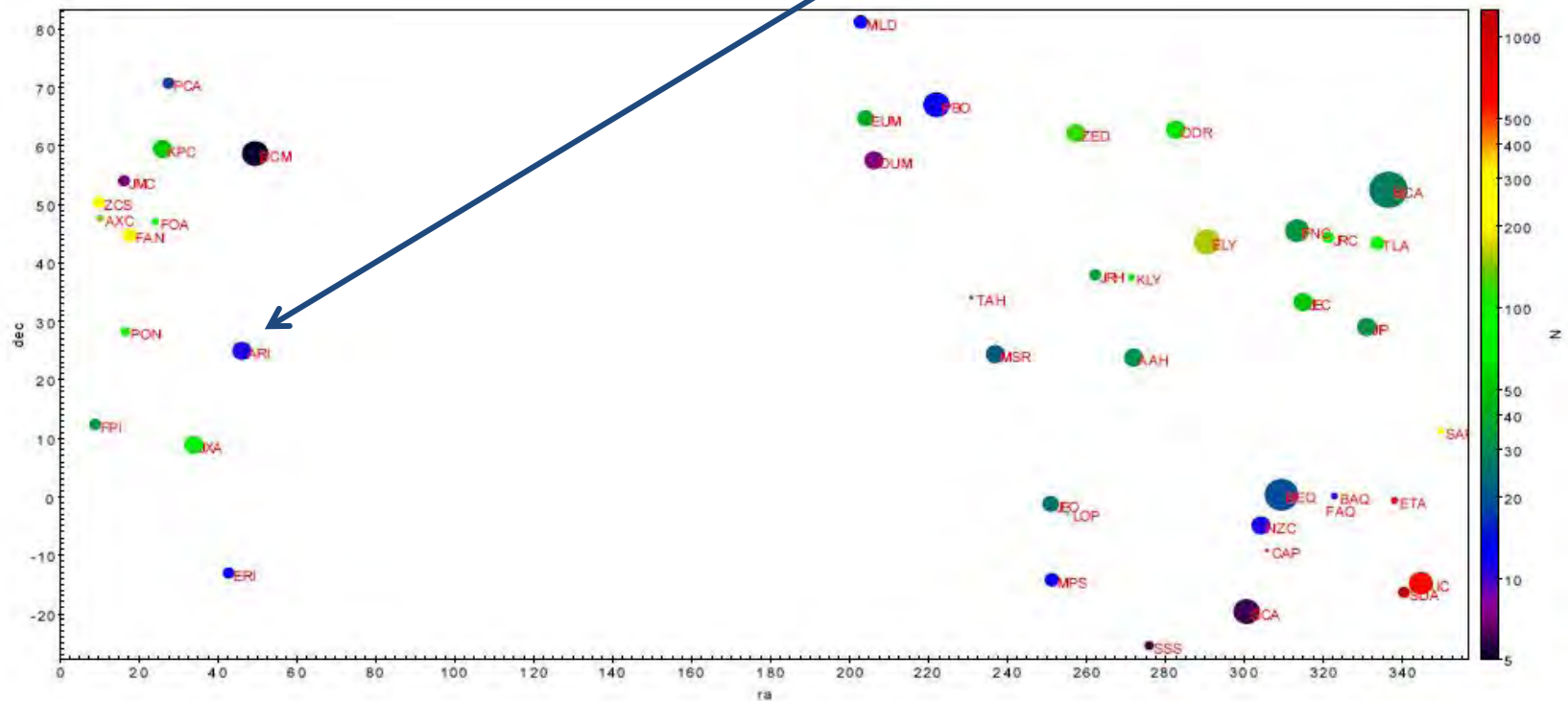


Figure 5: Identified summer meteor showers. Colour represents number of members of a shower, while the size represents D value based on the similarity measure between the mean orbital parameters of a cluster and linked with it the IAU MDC meteor shower (column 12 and 13 in Table 1 respectively).

Observing possibilities

Optical data?

Analyses of EDMOND data (Rudawska et al., 2014) include **221 DSX**

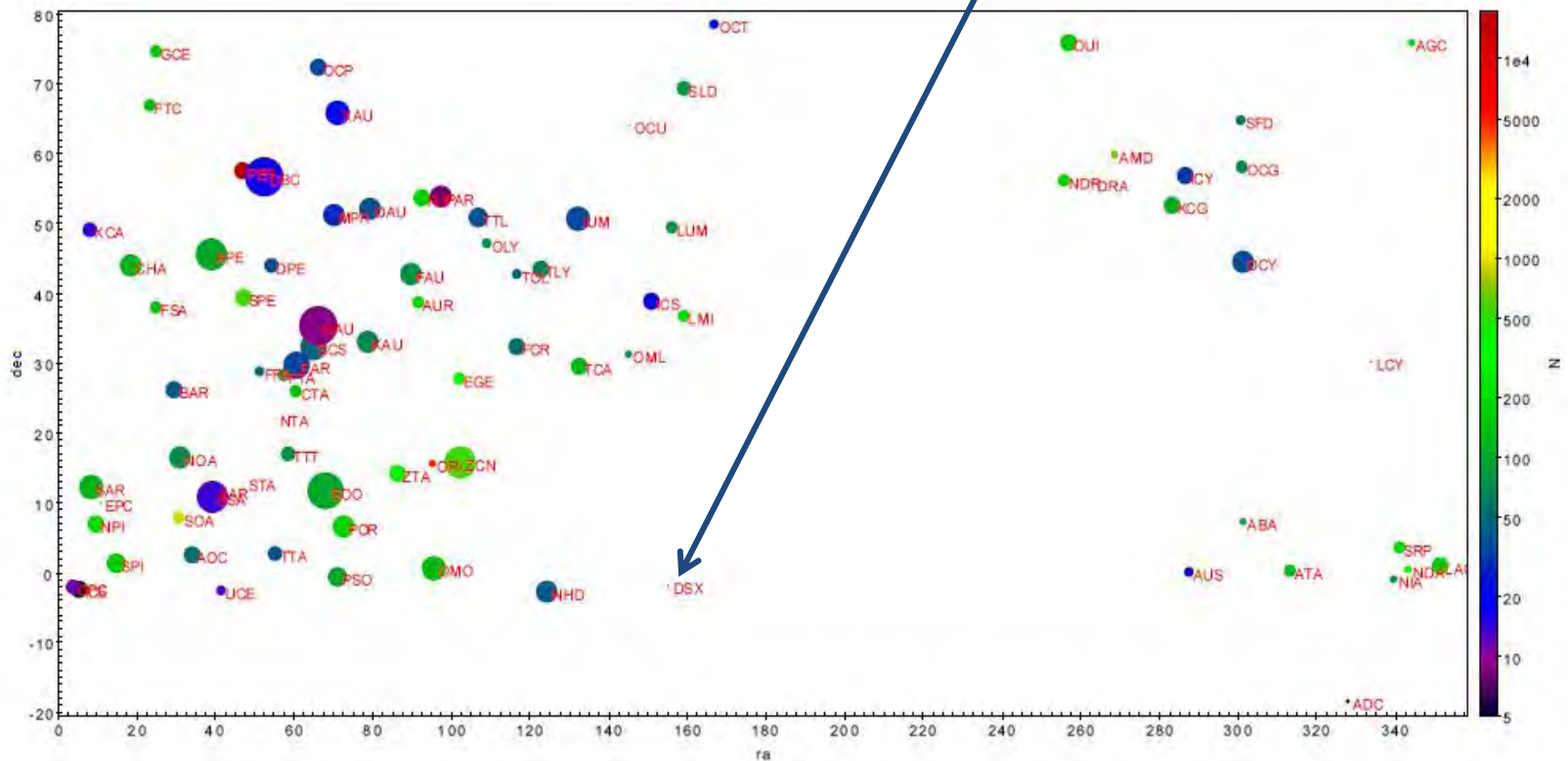


Figure 6: Identified autumn meteor showers. Colour represents number of members of a shower, while the size represents D value based on the similarity measure between the mean orbital parameters of a cluster and linked with it the IAU MDC meteor shower (column 12 and 13 in Table I respectively).

Observing possibilities

Optical data?

171 ARI early June

Radiant 10 deg (twilight)

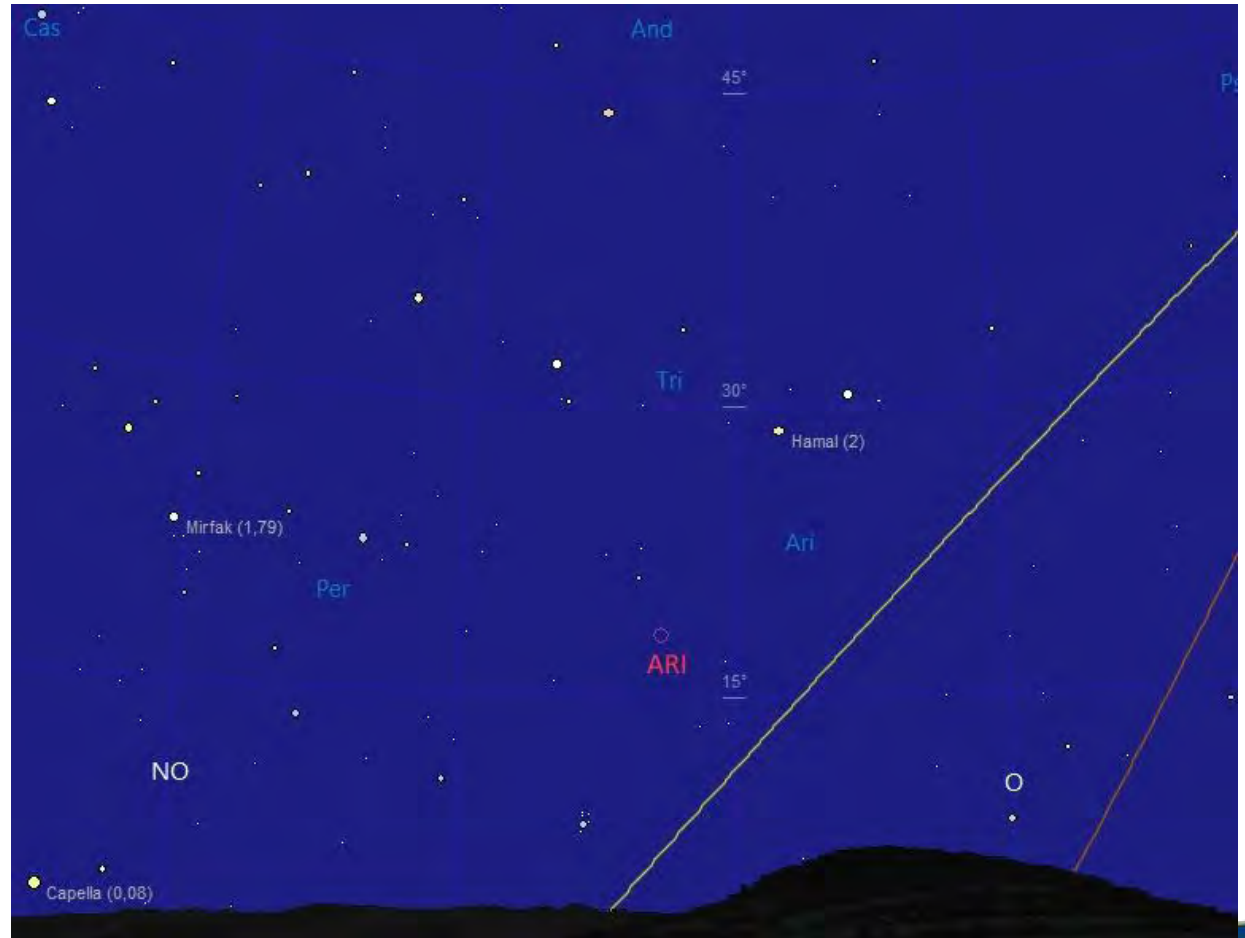
ZHR 10: n=2 (LM 6.5)

n=1 (LM 5.5)

ZHR 100: n=20 (LM 6.5)

n= 8 (LM 5.5)

Here: 30 deg N, 0430 h LT



Observing possibilities

Optical data?

221 DSX end September

slightly better (twilight)

Radiant ~ 10 deg

ZHR 10: n=2 (LM 6.5)

n=1 (LM 5.5)

ZHR 50: n=10 (LM 6.5)

n= 4 (LM 5.5)

Here: 30 deg N, 05 h LT



Proposal

Comprehensive data set

Target: 221 DSX

Optical data, including

video (add to radiant list)

visual (info to observers)

Both restricted to ~1hr/night

Radio data

Aim:

Calibration of data sets

Activity period, profile

Population/mass index

Period: Sep 22-Oct 5



Conclusion

Shower Calendar 2015 + Meteor Shower Workbook 2014

Shower	Activity	Max Date	λ_{\odot} 2000	Radiant		Best observed		Rate
				α	δ	50° N	35° S	
Sgr/Capricornids (115 DSC)	Jan 13–Feb 04	Feb 01	312°5	299°	−15°	11 ^h –14 ^h	09 ^h –14 ^h	Medium
χ -Capricornids (114 DXC)	Jan 29–Feb 28	Feb 13	324°7	315°	−24°	10 ^h –13 ^h	08 ^h –15 ^h	Low
April Piscids (144 APS)	Apr 20–Apr 26	Apr 22	32°5	9°	+11°	07 ^h –14 ^h	08 ^h –13 ^h	Low
ε -Arietids (154 DEA)	Apr 24–May 27	May 09	48°7	44°	+21°	08 ^h –15 ^h	10 ^h –14 ^h	Low
May Arietids (294 DMA)	May 04–Jun 06	May 16	55°5	37°	+18°	08 ^h –15 ^h	09 ^h –13 ^h	Low
S. May Arietids (156 SMA)	Apr 20–May 22	May 08	47°5	29°	+10°	08 ^h –15 ^h	09 ^h –13 ^h	Low
ϕ -Cetids (293 DCE)	May 05–Jun 02	May 20	59°3	28°	−04°	07 ^h –13 ^h	07 ^h –13 ^h	Low
N. ω -Cetids (152 NOC)	Apr 20–May 20	May 08	47°5	9°	+19°	07 ^h –13 ^h	07 ^h –13 ^h	Low
S. ω -Cetids (153 OCE)	Apr 24–May 20	May 10	49°5	23°	−03°	07 ^h –13 ^h	07 ^h –13 ^h	Low
Arietids (171 ARI)	May 14–Jun 24	Jun 07	76°5	42°	+25°	06 ^h –14 ^h	08 ^h –12 ^h	High
ζ -Perseids (172 ZPE)	May 07–Jun 26	Jun 14	83°5	65°	+28°	07 ^h –15 ^h	09 ^h –13 ^h	Low
β -Taurids (173 BTA)	Jun 12–Jul 04	Jun 28	96°5	85°	+23°	08 ^h –15 ^h	09 ^h –13 ^h	Low
γ -Leonids (203 GLE)	Aug 14–Sep 12	Aug 25	152°2	155°	+20°	08 ^h –16 ^h	10 ^h –14 ^h	Low
κ -Leonids (212 KLE)	Sep 06–Oct 03	Sep 21	178°5	159°	+18°	07 ^h –15 ^h	09 ^h –13 ^h	Low
Sextantids (221 DSX)	Sep 23–Oct 07	Sep 30	187°5	154°	00°	06 ^h –12 ^h	06 ^h –13 ^h	Medium

**Establish a revised Table step by step (select shower, high/low rate),
 apply various techniques (optical, radio),
 calibrate data,
 compare with radar data (r , ZHR/flux, activity)**

@187.5 deg: RA=154, De=0, V=32km/s, interval 180-195 deg

Conclusion

Shower Calendar 2015 + Meteor Shower Workbook 2014

Shower	Activity	Max Date	λ_{\odot} 2000	Radiant		Best observed		Rate
				α	δ	50° N	35° S	
Sgr/Capricornids (115 DSC)	Jan 13–Feb 04	Feb 01	312°5	299°	-15°	11 ^h –14 ^h	09 ^h –14 ^h	Medium
χ -Capricornids (114 DXC)	Jan 29–Feb 28	Feb 13	324°7	315°	-24°	10 ^h –13 ^h	08 ^h –15 ^h	Low
April Piscids (144 APS)	Apr 20–Apr 26	Apr 22	32°5	9°	+11°	07 ^h –14 ^h	08 ^h –13 ^h	Low
ε -Arietids (154 DEA)	Apr 24–May 27	May 09	48°7	44°	+21°	08 ^h –15 ^h	10 ^h –14 ^h	Low
May Arietids (294 DMA)	May 04–Jun 06	May 16	55°5	37°	+18°	08 ^h –15 ^h	09 ^h –13 ^h	Low
S. May Arietids (156 SMA)	Apr 20–May 22	May 08	47°5	29°	+10°	08 ^h –15 ^h	09 ^h –13 ^h	Low
ω -Cetids (293 DCE)	May 05–Jun 02	May 20	50°3	28°	-04°	07 ^h –13 ^h	07 ^h –13 ^h	Low
N. ω -Cetids (152 DCC)	Apr 20–May 20	May 03	47°5	19°	+11°	10 ^h –13 ^h	07 ^h –13 ^h	Low
S. ω -Cetids (113 DCE)	Apr 24–May 20	May 10	49°5	23°	-05°	07 ^h –13 ^h	07 ^h –13 ^h	Low
Arietids (171 ARI)	May 14–Jun 24	Jun 07	76°5	42°	+25°	06 ^h –14 ^h	08 ^h –12 ^h	High
ζ -Perseids (172 ZPE)	May 07–Jun 26	Jun 14	83°5	65°	+28°	07 ^h –15 ^h	09 ^h –13 ^h	Low
β -Taurids (173 BTA)	Jun 19–Jul 04	Jul 21	56°5	87°	+37°	08 ^h –15 ^h	09 ^h –13 ^h	Low
γ -Leonids (203 LE)	Aug 14–Sep 02	Sep 25	152°2	155°	+0°	08 ^h –16 ^h	10 ^h –14 ^h	Low
κ -Leonids (212 KLE)	Sep 06–Oct 03	Sep 21	178°5	159°	+18°	07 ^h –15 ^h	09 ^h –13 ^h	Low
Sextantids (221 DSX)	Sep 23–Oct 07	Sep 30	187°5	154°	00°	06 ^h –12 ^h	06 ^h –13 ^h	Medium

September 2014:
221 DSX first project

Establish a revised Table step by step (select shower, high/low rate),
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@187.5 deg: RA=154, De=0, V=32km/s, interval 180-195 deg