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Modelling of meteoroid impacts on Phobos

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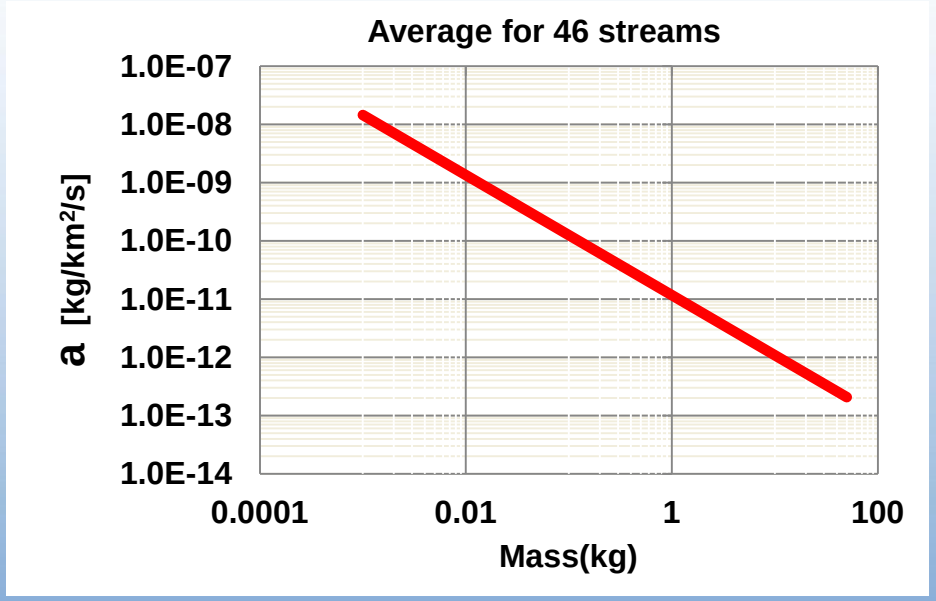
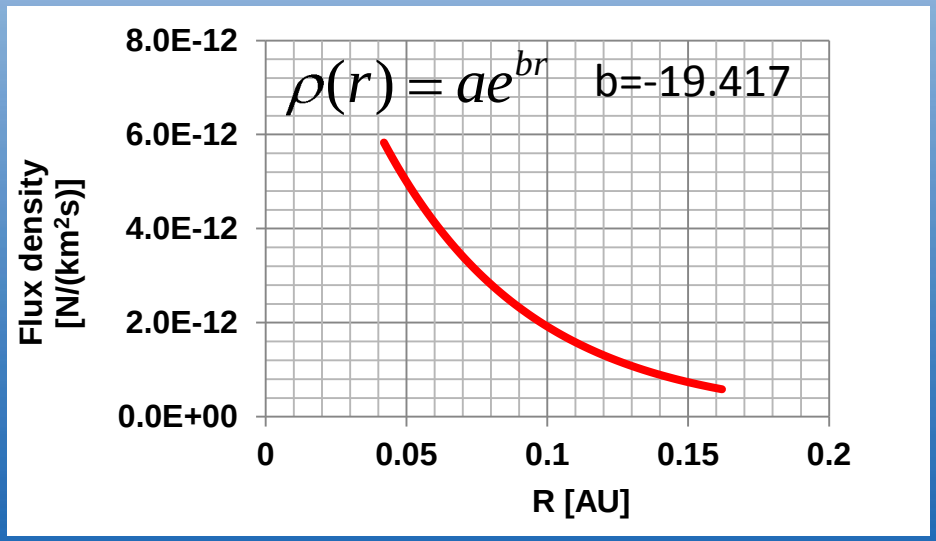
Model of spatial distribution of meteoroids

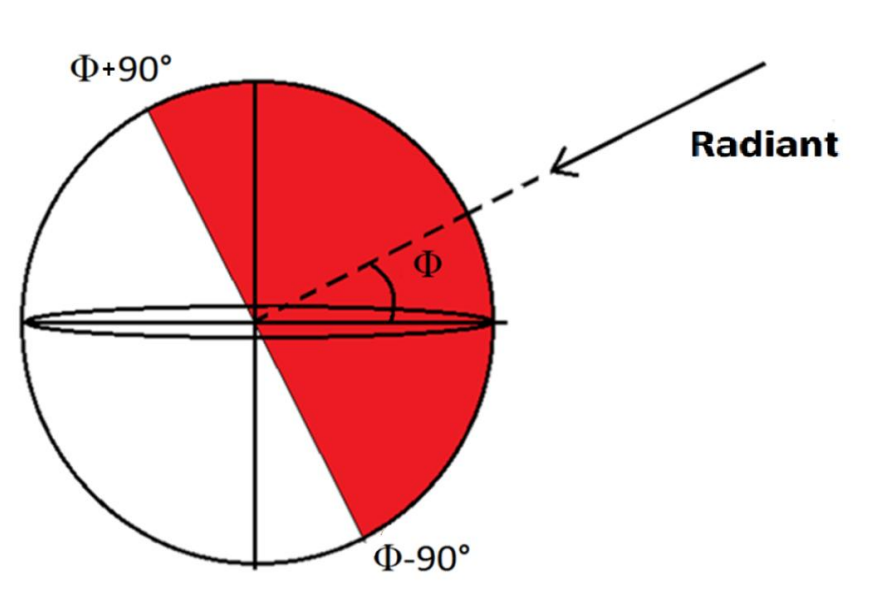


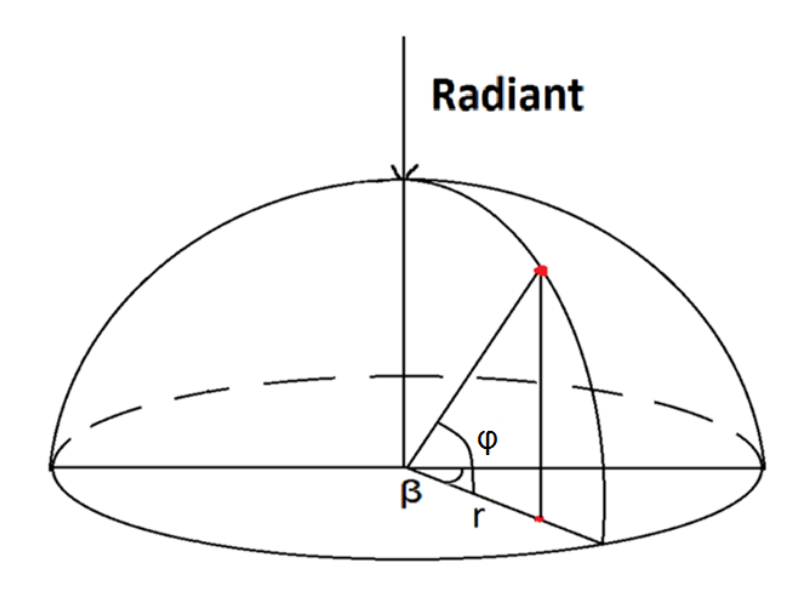


- Database of 1037 periodical comets was analyzed, and 137 potential parent bodies of Martian meteoroid streams were identified. Model of spatial distribution of cometary meteoroids was constructed by using known parameters of 46 terrestrial meteoroid streams.
- Database of 28,000 asteroids was analyzed, and 5957 potential parent bodies of Martian meteoroids were identified. It is assumed that small non-observed asteroids move at orbits close to known near Mars asteroids. Each known asteroid with magnitude *H0* is associated with *N* small non-observed asteroids with magnitude *H*:

Modeling of asteroid impact probability was performed by using Opik 1976 method.

Calculation of the coordinates of meteoroids impacts using a random number generator





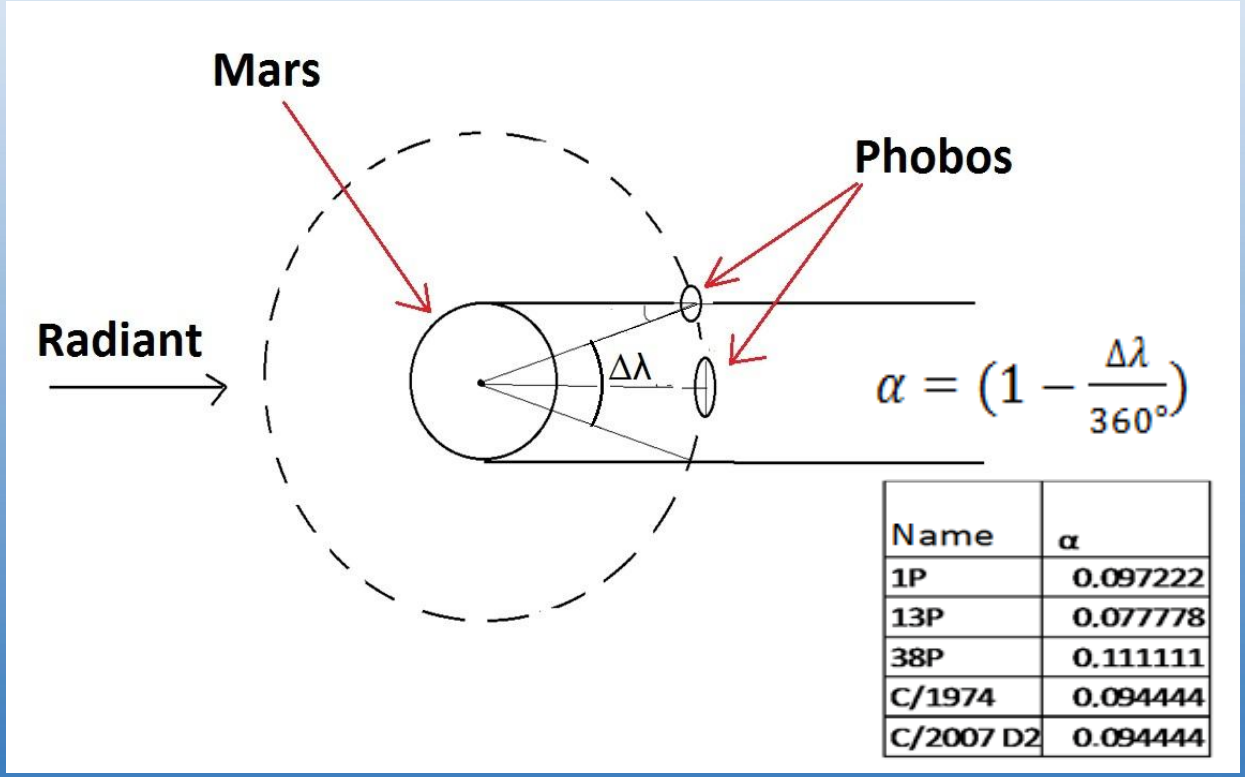
Coverage area of each meteor stream:

Latitude: (Φ-90° < φ < Φ +90°), where Φ is radiant latitude - the angle between the radiant and Phobos equator.

Longitude: 0° to 360°

Screening of meteoroids by Mars

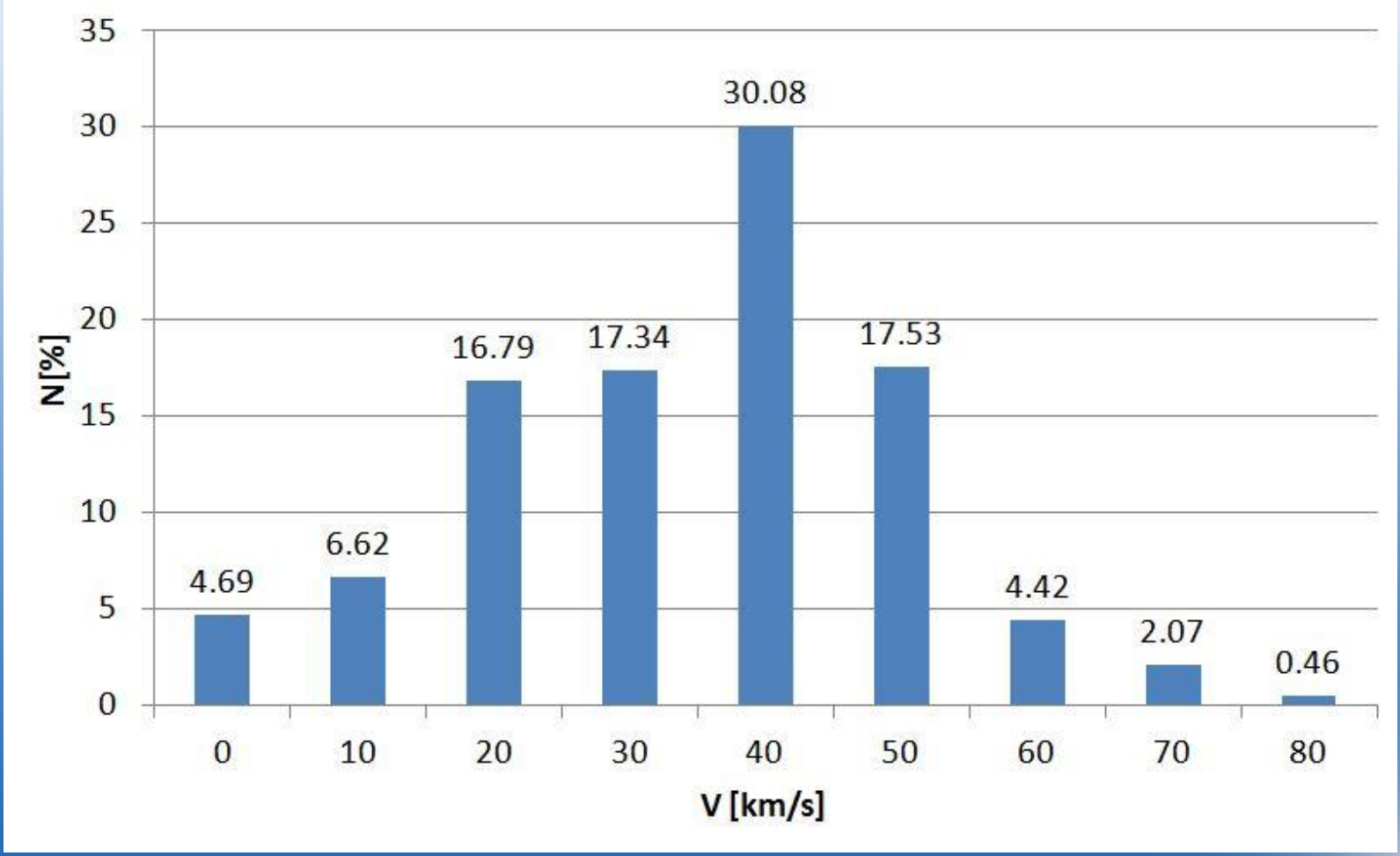
Effect of Mars screening may take place for streams with orbit inclination to Phobos orbit less than ~20 (the angle at which Mars is visible from Phobos).



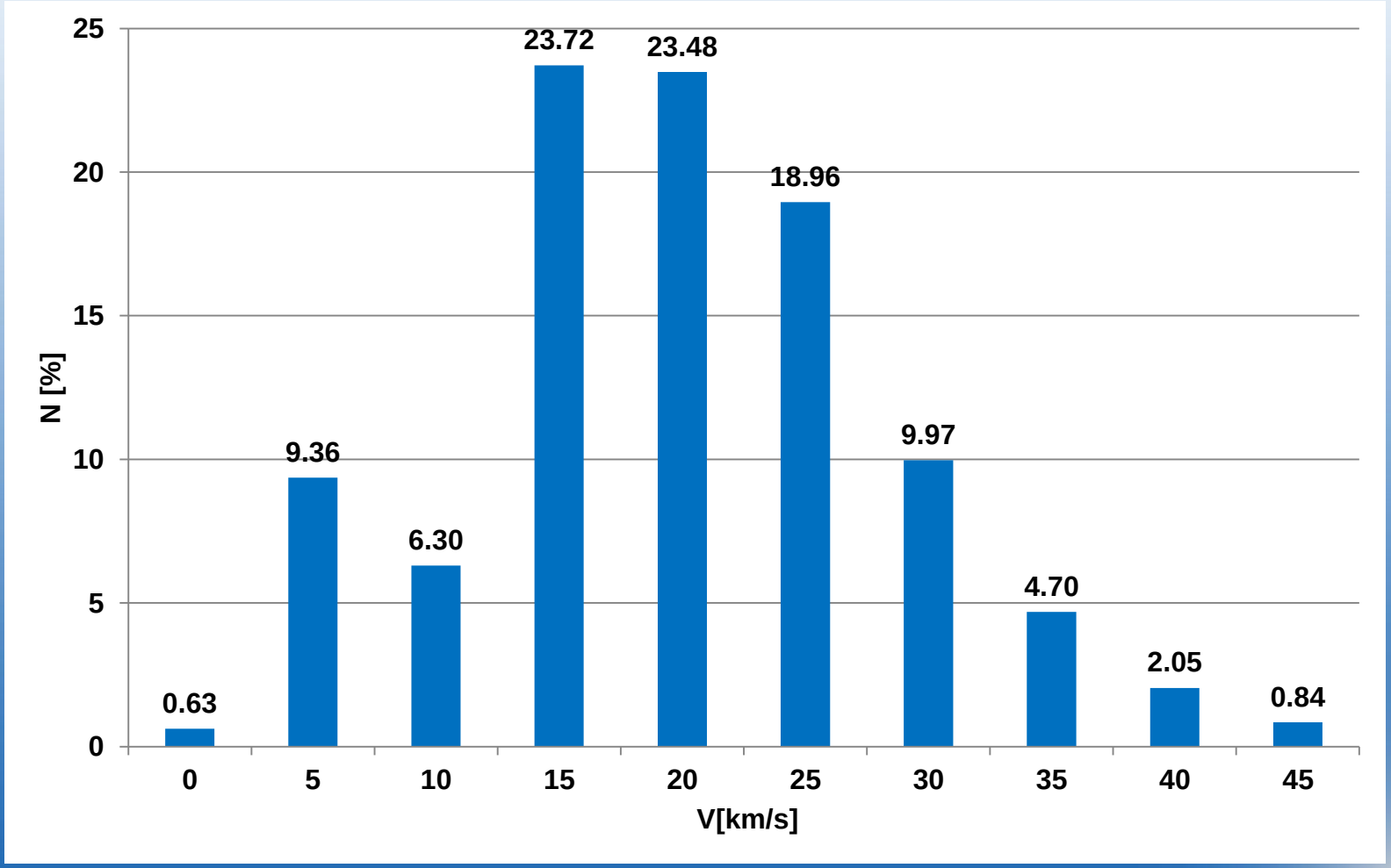
Name	α
1P	0.097222
13P	0.077778
38P	0.111111
C/1974	0.094444
C/2007 D2	0.094444

Example: Meteoroid showers, which are subject to screening and the screening coefficient **α** (part of meteoroids stopped by Mars).

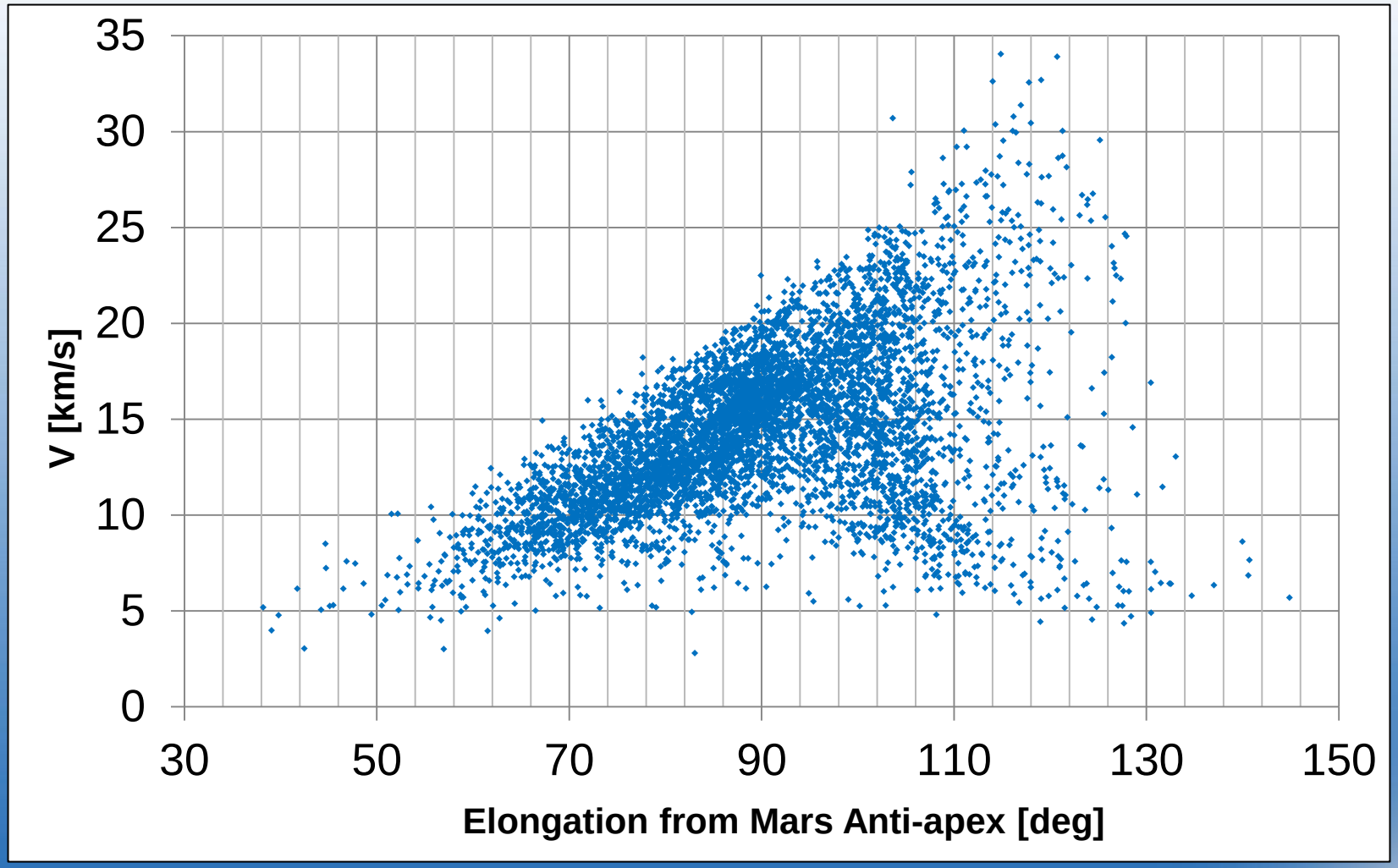
Cometary meteoroids impact velocity distribution for long periodic comets



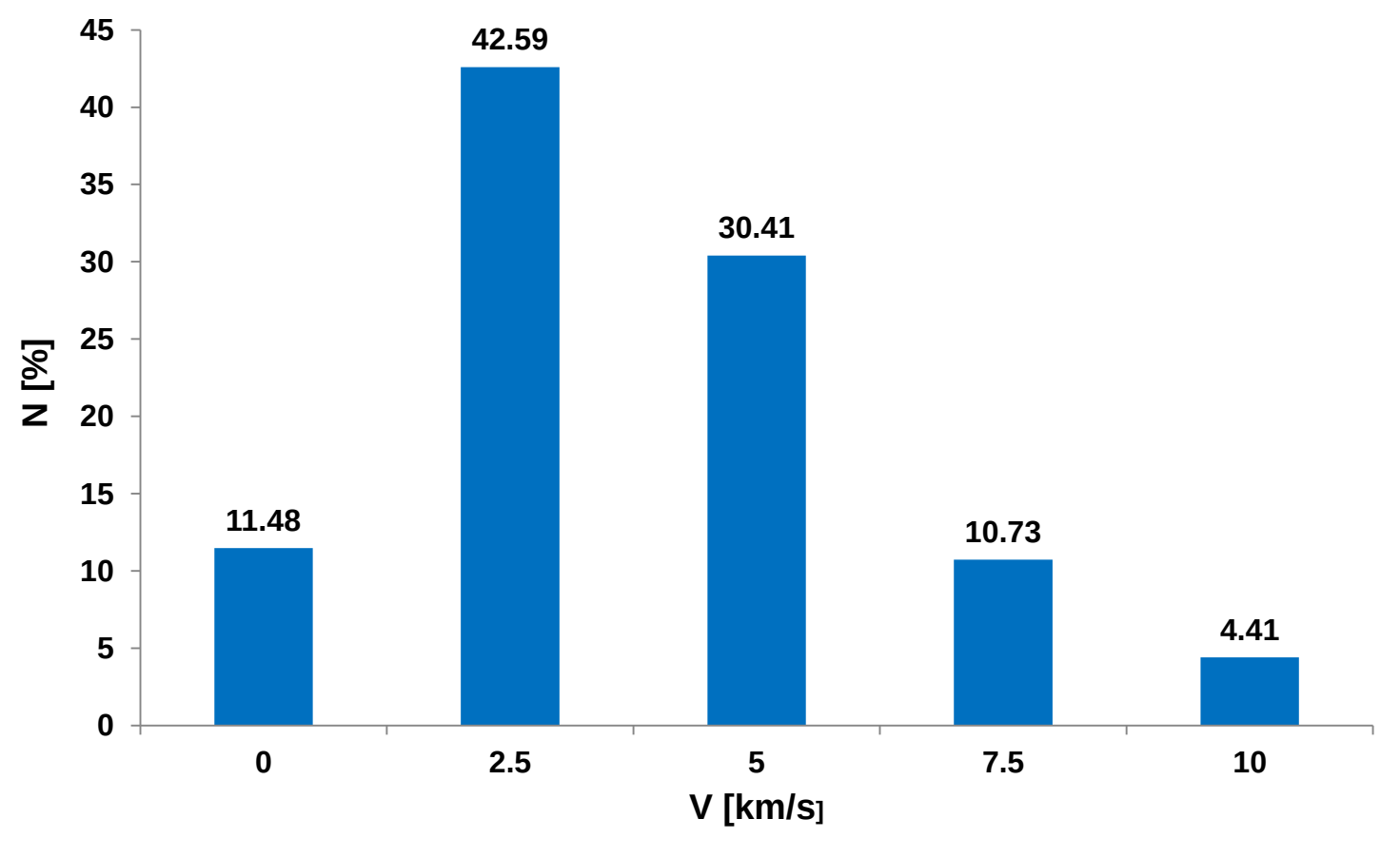
Cometary meteoroids impact velocity distribution for Jupiter-family comets



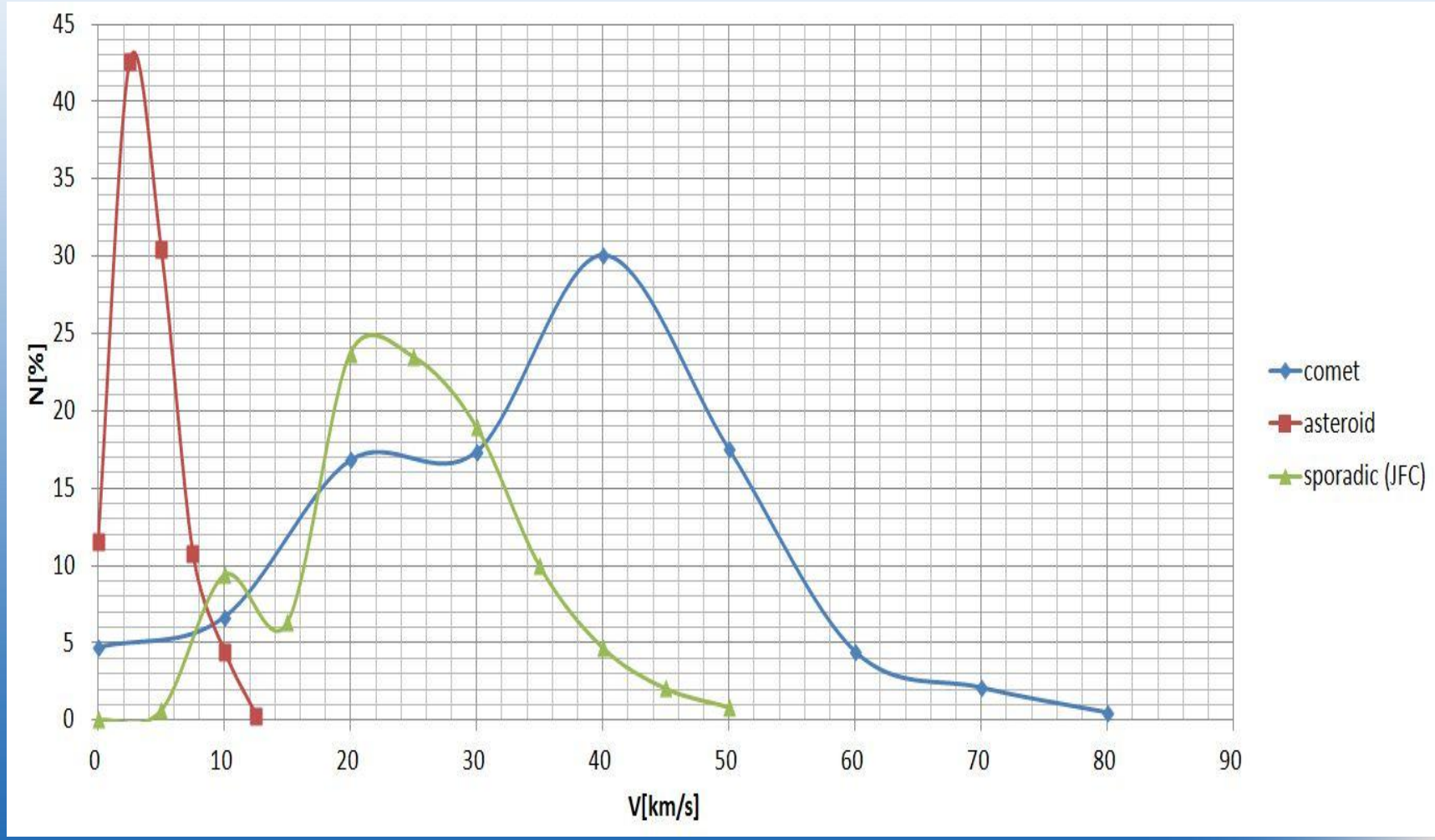
Mars approaching asteroids orbital velocity distribution



Asteroidal meteoroids impact velocity distribution

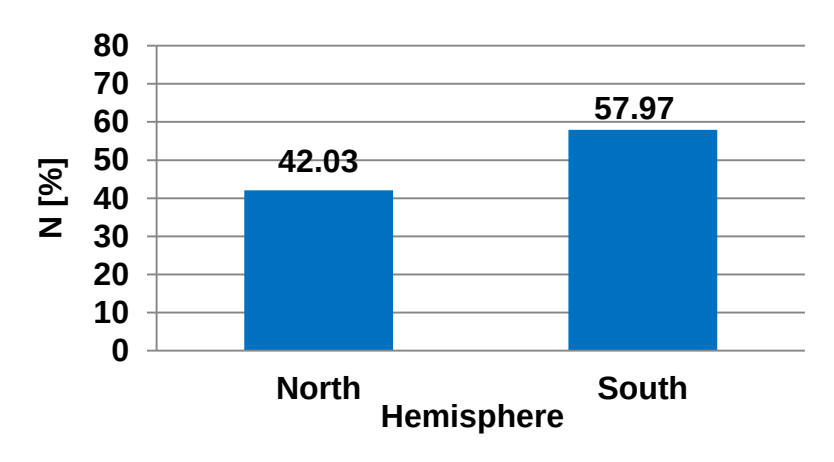


Meteoroids impact velocity distribution

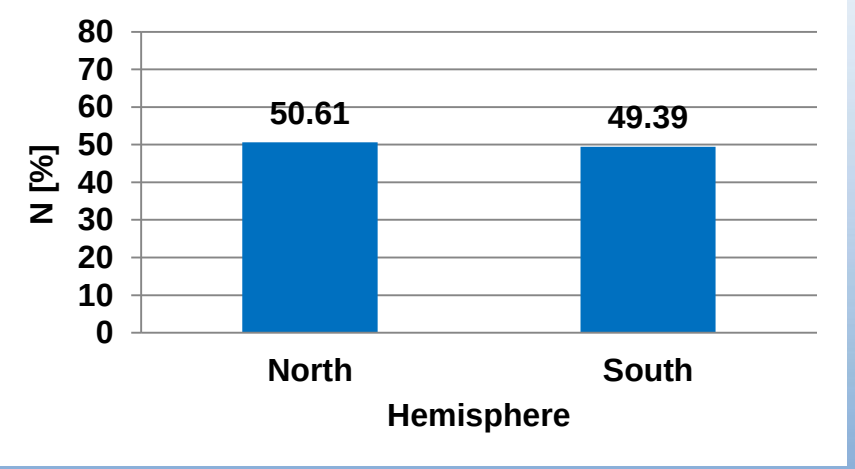


Cometary meteoroids impact statistics for the North and South hemispheres

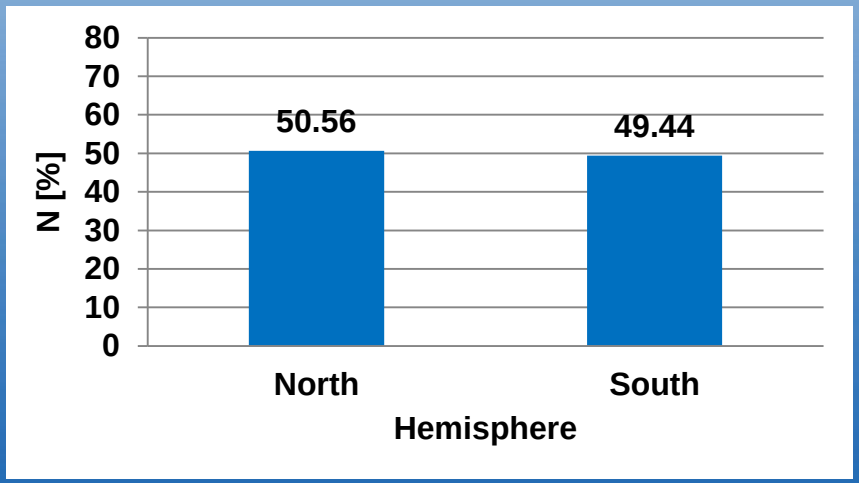
Jupiter-family comets



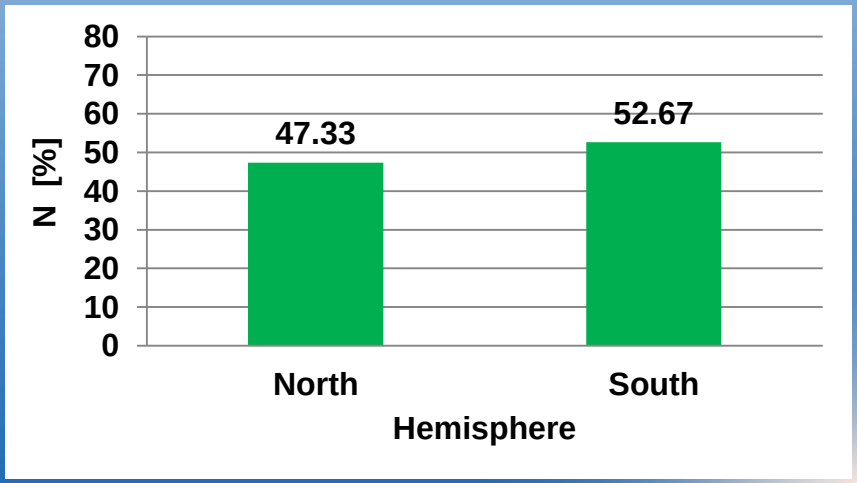
Long periodic comets



Asteroids



Observations for craters with diameter > 100 m



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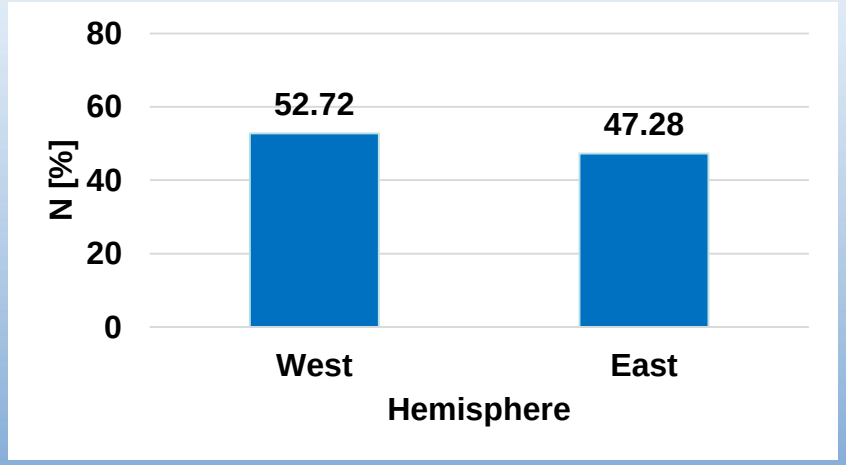
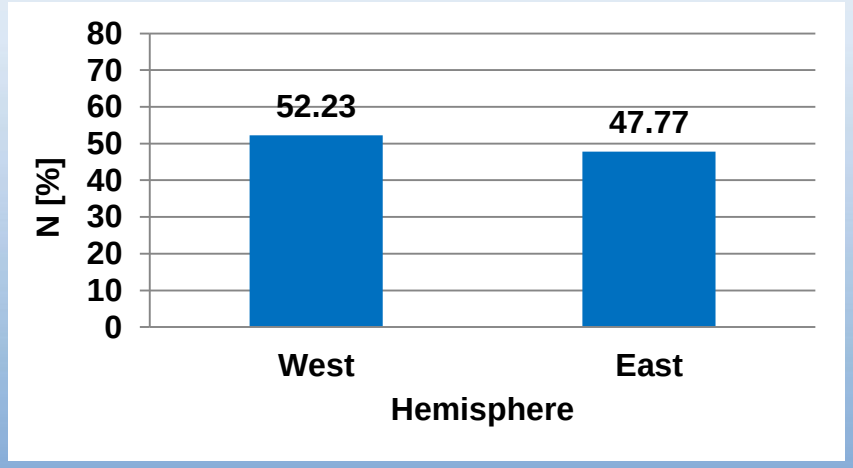
Cometary meteoroids impact statistics for the West and East hemispheres

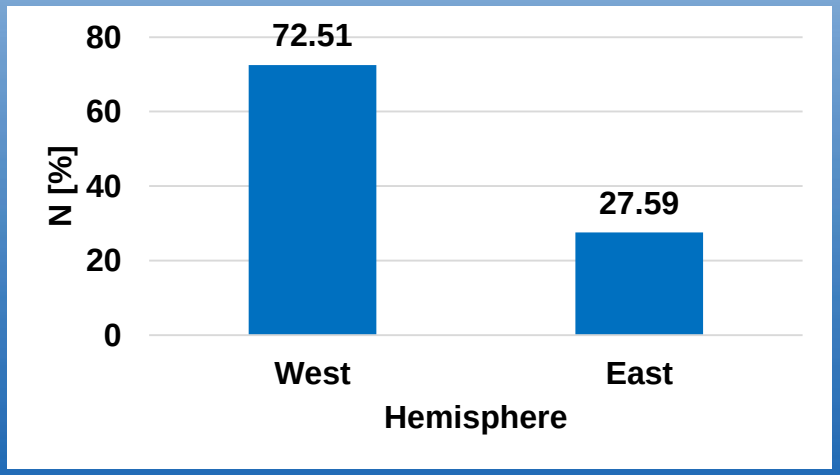
Jupiter-family comets



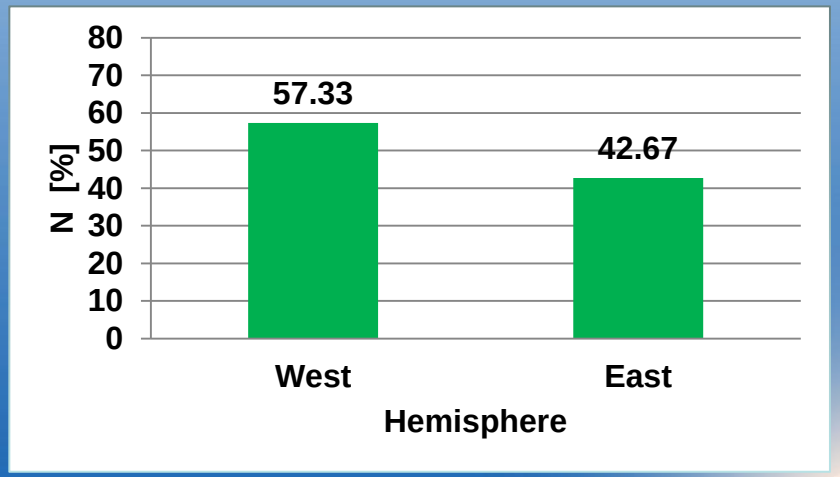
Long periodic comets



Asteroids



Observations for craters with diameter > 100 m



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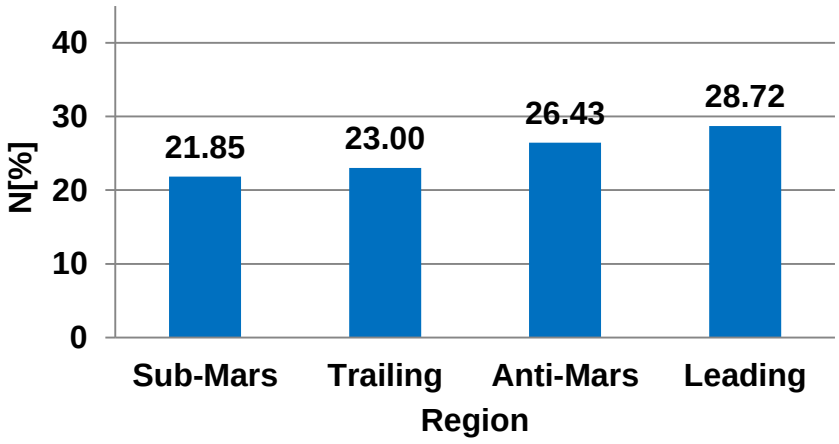
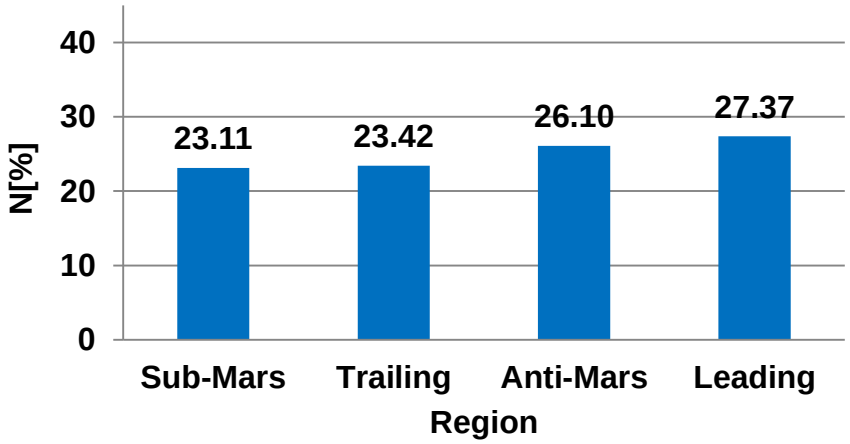
Impact statistics for the 90 degrees longitude zones

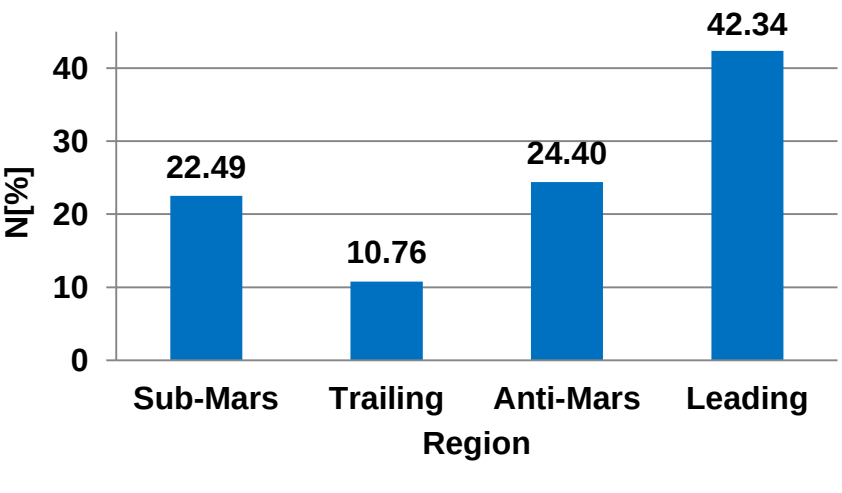
Jupiter-family comets



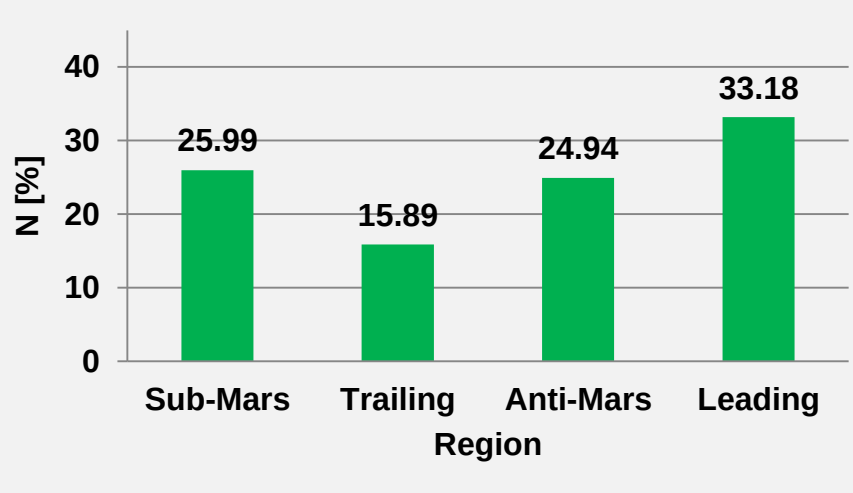
Long periodic comets



Asteroids

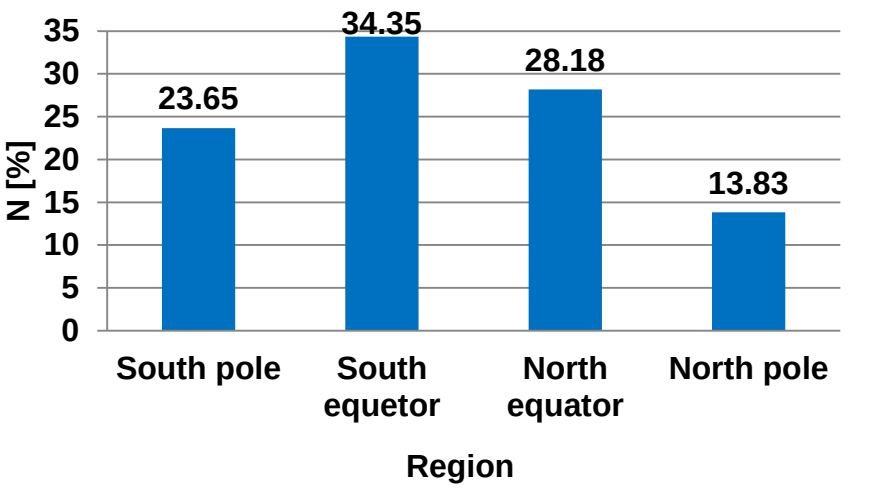


Observations for craters with diameter > 100 m

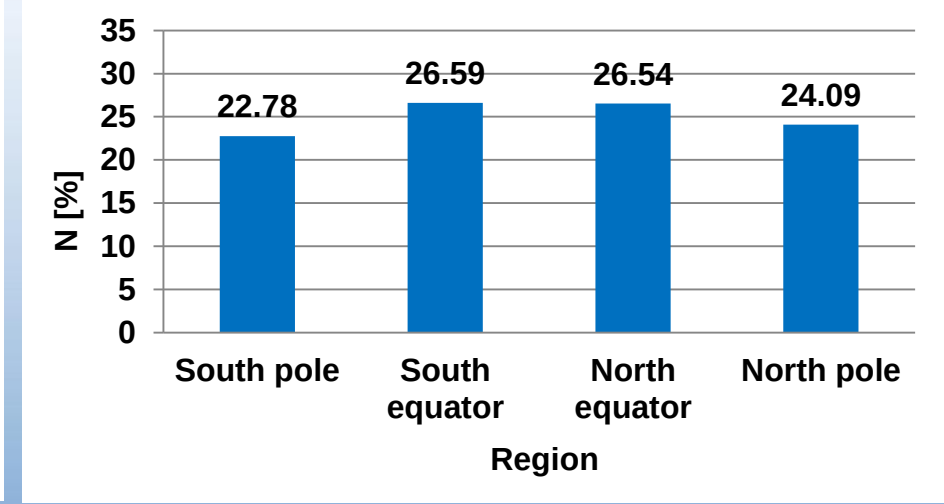


Impact statistics for equal-area latitude zones

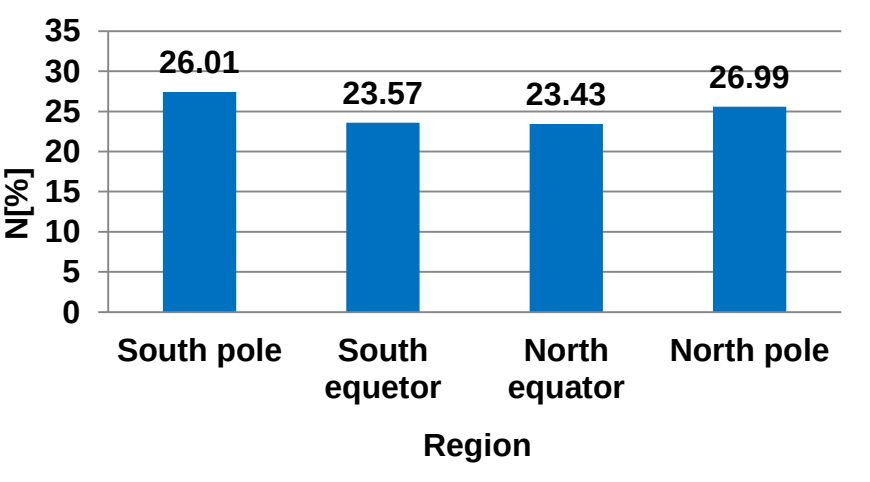
Jupiter-family comets



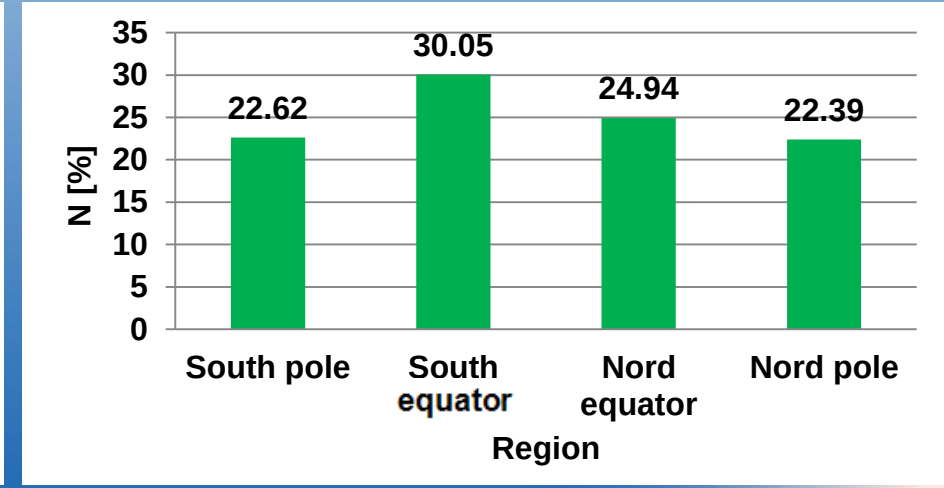
Long periodic comets



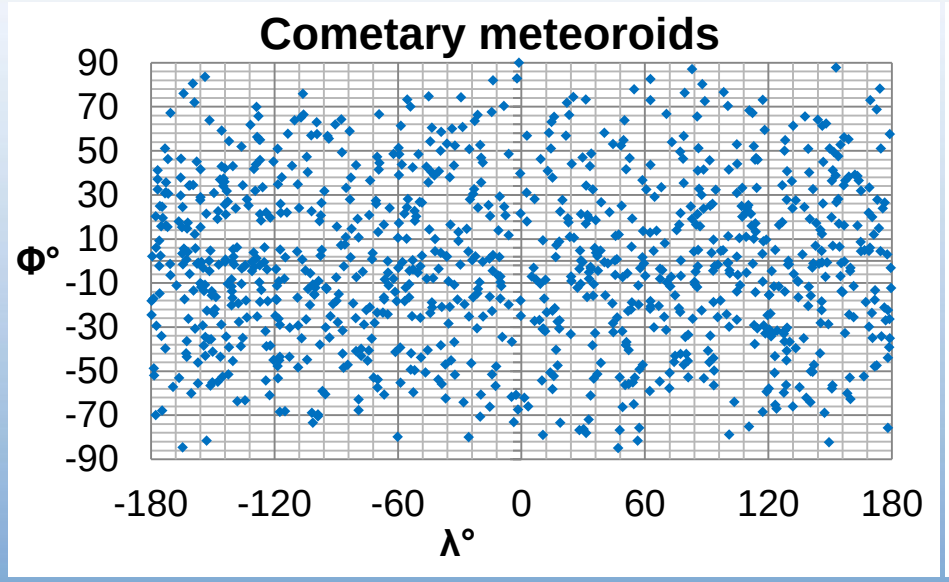
Asteroids

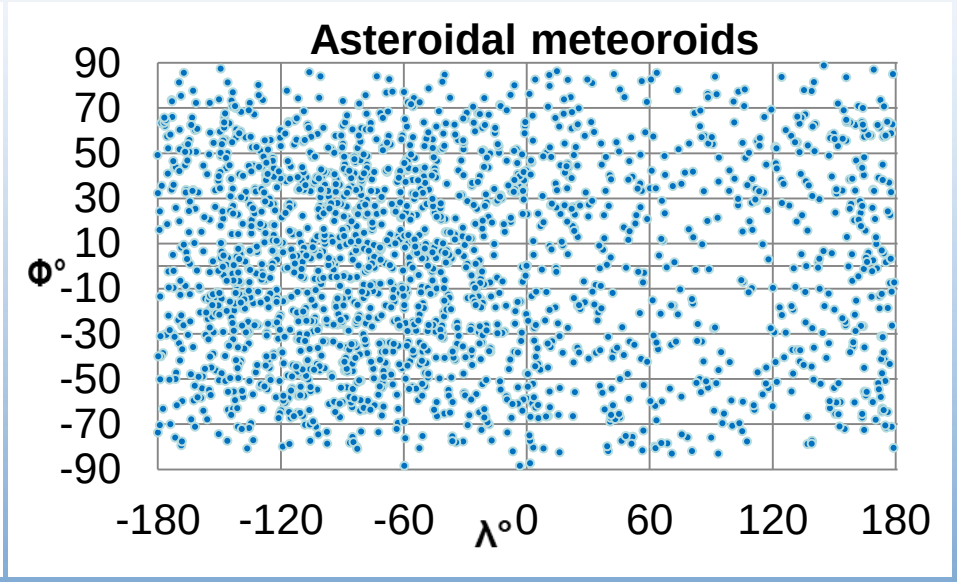


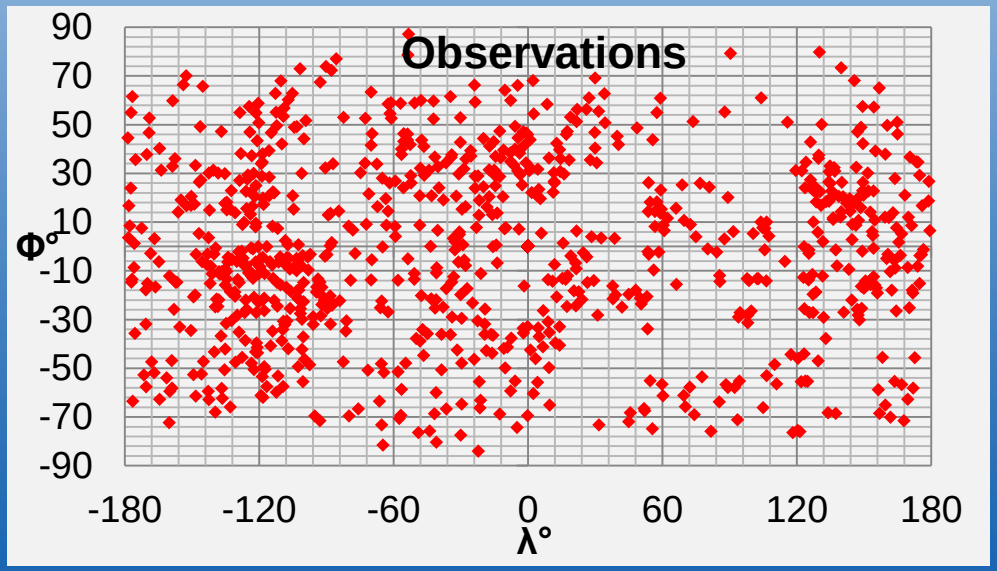
Observations for craters with diameter > 100 m



Comparison of observed and simulated crater distribution







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Statistics of model and observed meteoroid impact craters on Phobos

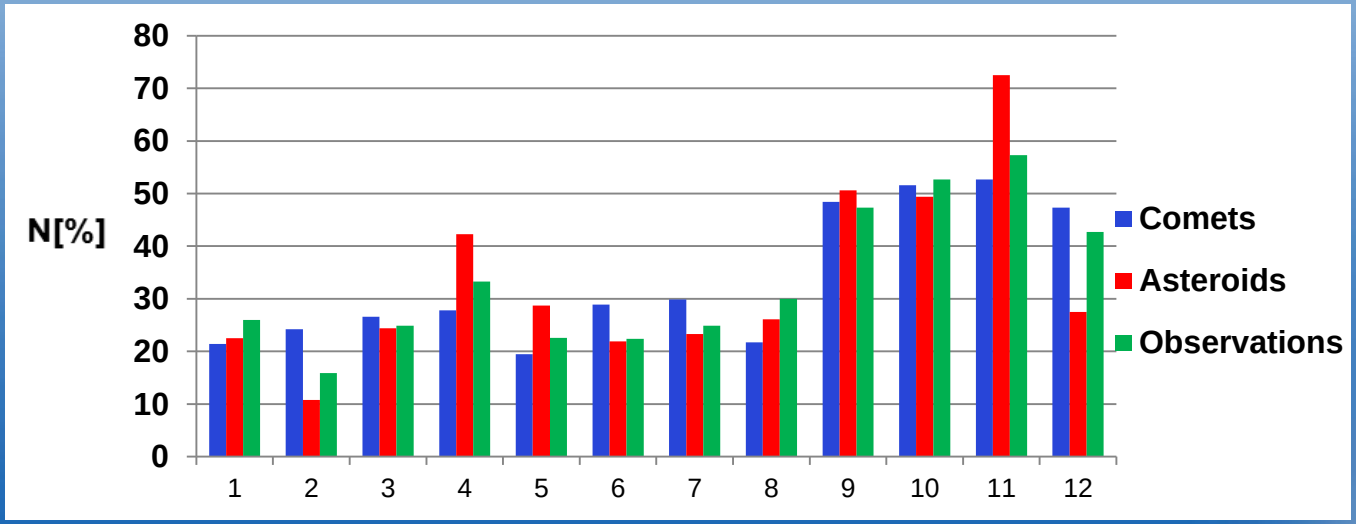
Location on Phobos	Long Period Comets	Jupiter-Family Comets	All Comets	Asteroids	Observations
	N[%]	N[%]	N[%]	N[%]	N[%]
Sub-Mars (-45° < λ < 45°)	23.1±1.3	21.8±1.3	21.4±1.3	22.5±1.3	26.0
Trailing (45° < λ < 135°)	23.4±1.3	23.0±1.4	24.2±1.4	10.8±0.9	15.9
Anti-Mars (135° < λ < 225°)	26.1±1.4	26.4±1.4	26.6±1.4	24.4±1.4	24.9
Leading (225° < λ < 315°)	27.4±1.5	28.7±1.5	27.8±1.5	42.3±1.8	33.3
North Polar (φ > 30°)	24.1±1.4	13.8±1.3	19.5±1.2	27.0±1.5	22.6
North Equatorial (0° < φ < 30°)	26.6±1.4	28.2±1.5	28.9±1.5	23.4±1.3	22.4
South Equatorial (-30° < φ < 0°)	26.6±1.4	34.4±1.5	29.9±1.5	23.6±1.3	24.9
South Polar (φ < -30°)	22.8±1.4	23.6±1.2	21.7±1.3	26.0±1.4	30.0
Northern Hemisphere	50.6±2.0	42.0±1.9	48.4±1.9	50.6±2.0	47.3
Southern Hemisphere	49.4±1.9	58.0±2.0	51.6±1.9	49.4±1.9	52.7
Western Hemisphere	52.2±2.0	52.7±2.0	52.7±2.0	72.5±2.5	57.3
Eastern Hemisphere	47.8±1.9	47.3±1.9	47.3±1.9	27.5±1.4	42.7

Summary

- Average impact velocity for the leading trailing hemispheres

Average velocity by hemisphere, [km/s]		
Meteoroid	**Leading**	**Trailing**
LPC	**42.4**	**41.1**
JFC	**23.0**	**21.8**
Asteroidal	**5.4**	**4.5**

- Average effect of the meteoroid screening by Mars for sub-Mars hemisphere is about 11% for cometary and 2% for asteroidal meteoroids.
- Simulated crater distribution is well correlated with observations



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Thank You !

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