Adapter to meteor TV camera for observations of shower's weakest meteors

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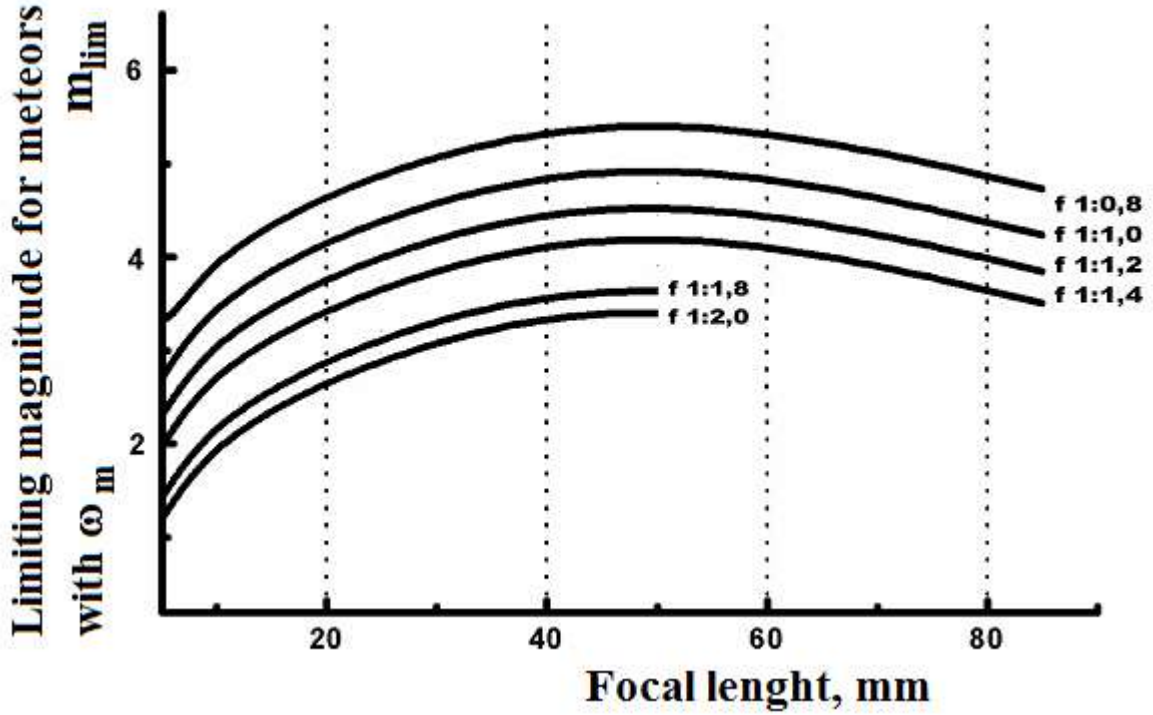
Population index enigma

- There is an enigma of mass/brightness distribution of meteors. From visual, photographic and numerous TV meteor observation we know that number of meteors with brightness (**m**+1) increases comparatively to number of meteors with brightness **m** as power about 1.7 … 2.3. Nevertheless it is hardly to believe that number of weak meteors can grow infinitely

Meteor limiting brightness

- There is a lower limit on the mass of meteor particles that can produce light phenomenon called a meteor. The weakest meteors that can still be observed using hybrid TV cameras have a brightness of approximately 7^m. Even if we assume that the whole light energy of meteor equals to the kinetic energy of the particle at the speed of 10 km/s, its mass must be 10^{-6} g. (at a particle velocity of 70 km / s, its mass will be equal to $6 * 10^{-8}$ g). In any case, the minimal brightness of faint meteors is located near the limiting magnitude of meteor cameras. So there is the challenge of meteor observations in the brightness range from $+ 3^m$ to $+ 7^m$.

Natural limits for meteors registration in optic



The limiting magnitude for meteors dependence on lens parameters for well-known WATEC 902 LCL 902 or its successors, when angular meteor velocity ω_m = 5º/sec

Bagrov A.V. and Leonov V.A. Correct brightness estimations of optical meteors. // Proceedings of the International Meteor Conference. Poznan, Poland, 22-25 August, 2013. - pp.142-146

Real limiting power of some meteor TV cameras

Meteor angular velocity ⇨ / Camera parameters ⇩	2.5°/sec	5°/sec	7.5°/ sec	10°/ sec	12.5°/ sec	15°/ sec
q=8.5 мкм; F=3.8 мм; τ_e=0.04 сек	$+0.0^m$	-0.5^m	-0.9^m	-1.2^m	-1.5^m	-1.7^m
q=8.5 мкм; F=4.0 мм; τ_e=0.04 сек	$+0.0^m$	-0.5^m	-1.0^m	-1.3^m	-1.6^m	-1.8^m
q=8.5 мкм; F=4.5 мм; τ_e=0.04 сек	$+0.0^m$	-0.7^m	-1.1^m	-1.6^m	-1.7^m	-1.9^m
q=8.5 мкм; F=6.0 мм; τ_e=0.04 сек	-0.2^m	-1.0^m	-1.4^m	-1.7^m	-2.0^m	-2.2^m
q=8.5 мкм; F=8.0 мм; τ_e=0.04 сек	-0.5^m	-1.3^m	-1.7^m	-2.1^m	-2.3^m	-2.5^m
q=8.5 мкм; F=12 мм; τ_e=0.04 сек	-1.0^m	-1.7^m	-2.1^m	-2.5^m	-2.7^m	-2.9^m
q=8.5 мкм; F=25 мм; τ_e=0.04 сек	-1.8^m	-2.5^m	-3.0^m	-3.2^m	-3.5^m	-3.7^m
q=8.5 мкм; F=50 мм; τ_e=0.04 сек	-2.5^m	-3.3^m	-3.7^m	-4.0^m	-4.3^m	-4.5^m
q=6.45 мкм; F=40 мм; τ_e=0.13 сек	-3.9^m	-4.6^m	-5.0^m	-5.3^m	-5.6^m	-5.8^m
q=6.45 мкм; F=85 мм; τ_e=0.13 сек	-4.7^m	-5.4^m	-5.8^m	-6.2^m	-6.4^m	-6.6^m
Naked eye	-1.5^m	-2.2^m	-2.7^m	-3.0^m	-3.2^m	-3.4^m

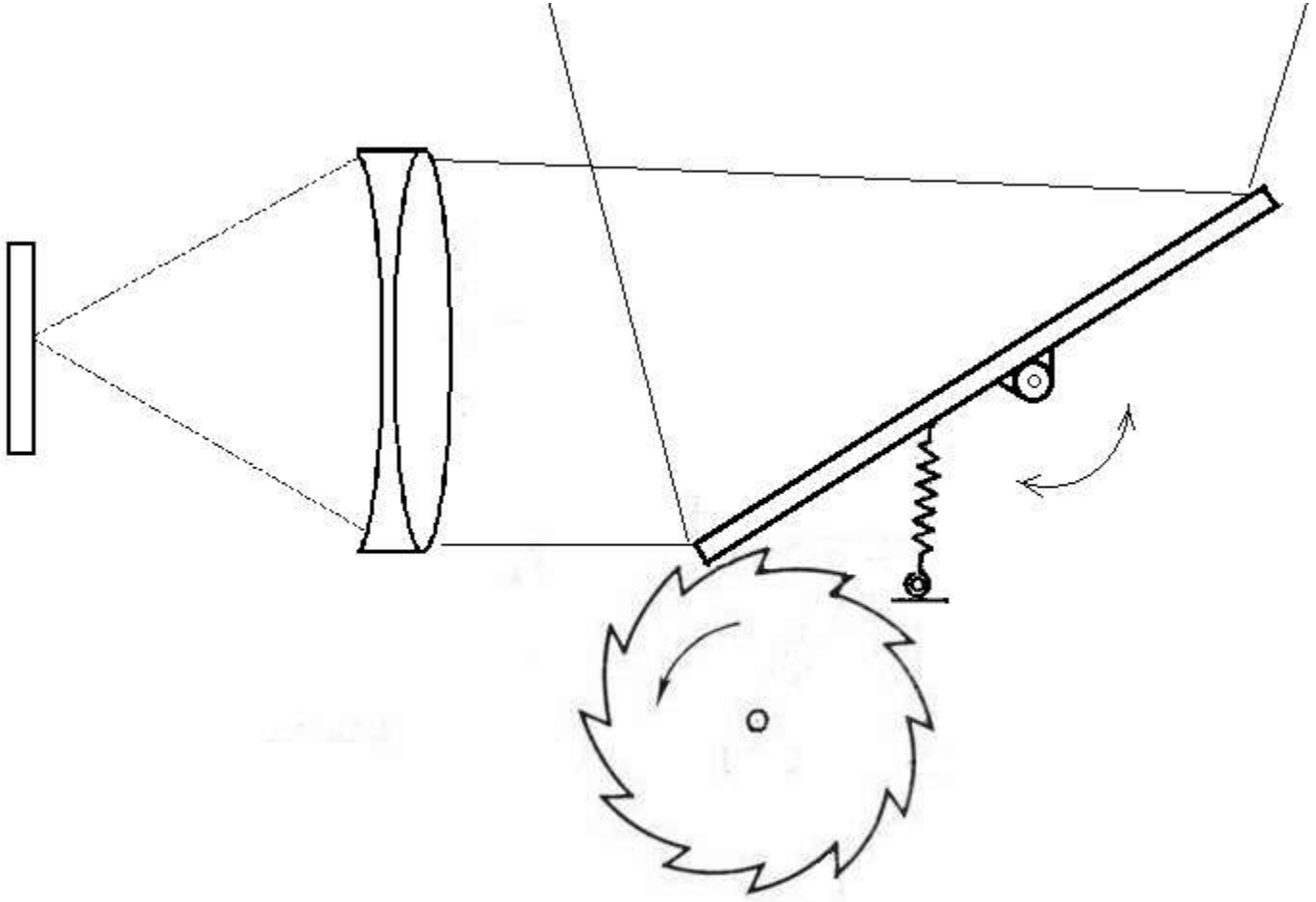
A difference between limiting magnitude for meteors and limiting magnitude for stars for some meteor TV-cameras as a function of meteor angular velocity

How to increase limiting power for meteors?

All meteor TV-cameras record meteor images as elongated tracks with short exposures. If all the light from meteor to collect into point-like patch, and exposure increase up to 0.7c (average duration of meteor glow), it would increase limiting magnitude of these cameras at least on 4m.

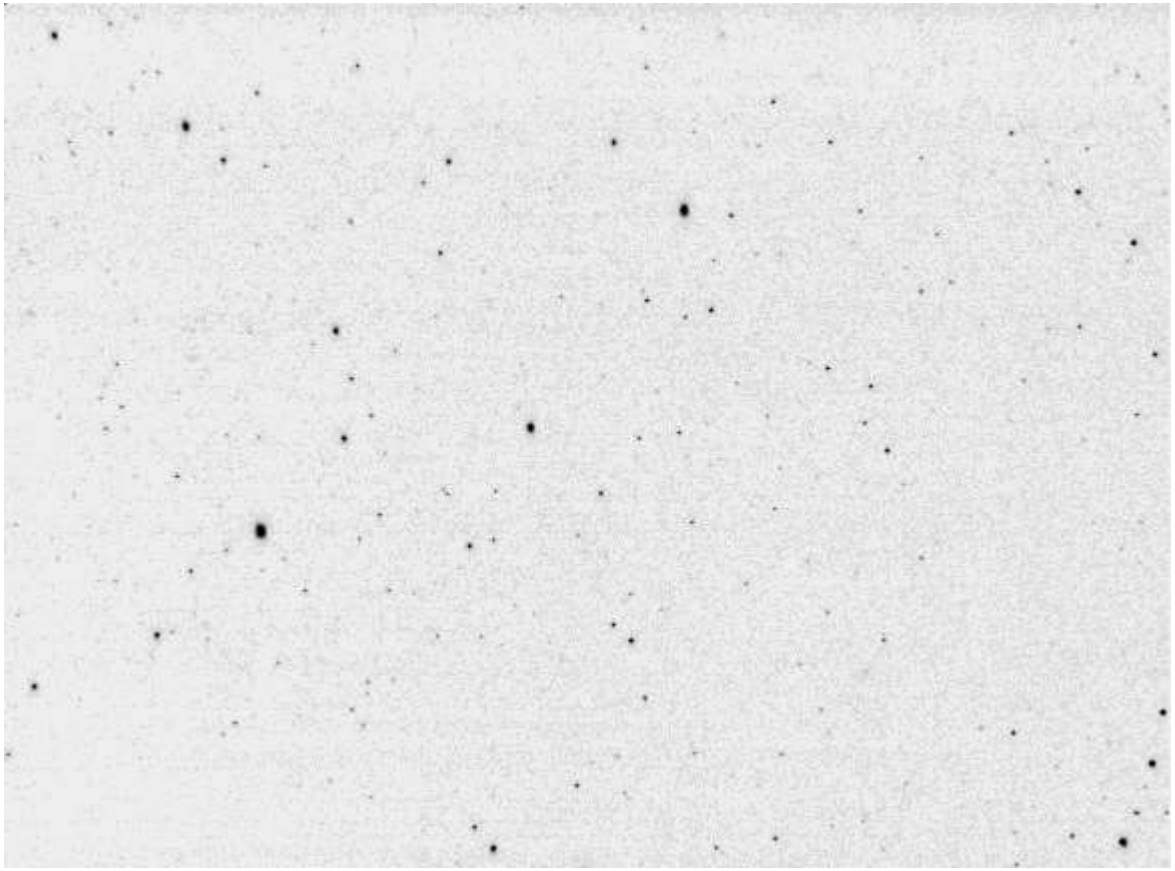
We propose a simple adapter to meteor TV-cameras to increase limiting magnitude of TV-cameras for meteors up to their limiting power for stars, that compensates for the apparent movement of the meteor in the frame. It consists of flat mirror, installed in front of the lens of the camera, which rotates with constant angular velocity during exposure time. The rotational speed of the mirror is chosen such that compensate for the apparent motion of the meteors from observed meteor shower. Of course, in a wide field of camera view visible movements compensation the meteors will be incomplete, even for one of the analyzed shower. Pendulum mirror of the adapter turns a corner, and then quickly returns to its initial position for next scan. As a result of his work the image of meteors become compact objects, while the images of all the stars in the frame to become stretched. Thus limiting power of the camera for meteors becomes close to the limiting power of the same camera for the stars.

Scheme of adapter with pendulum flat mirror for following shower meteors



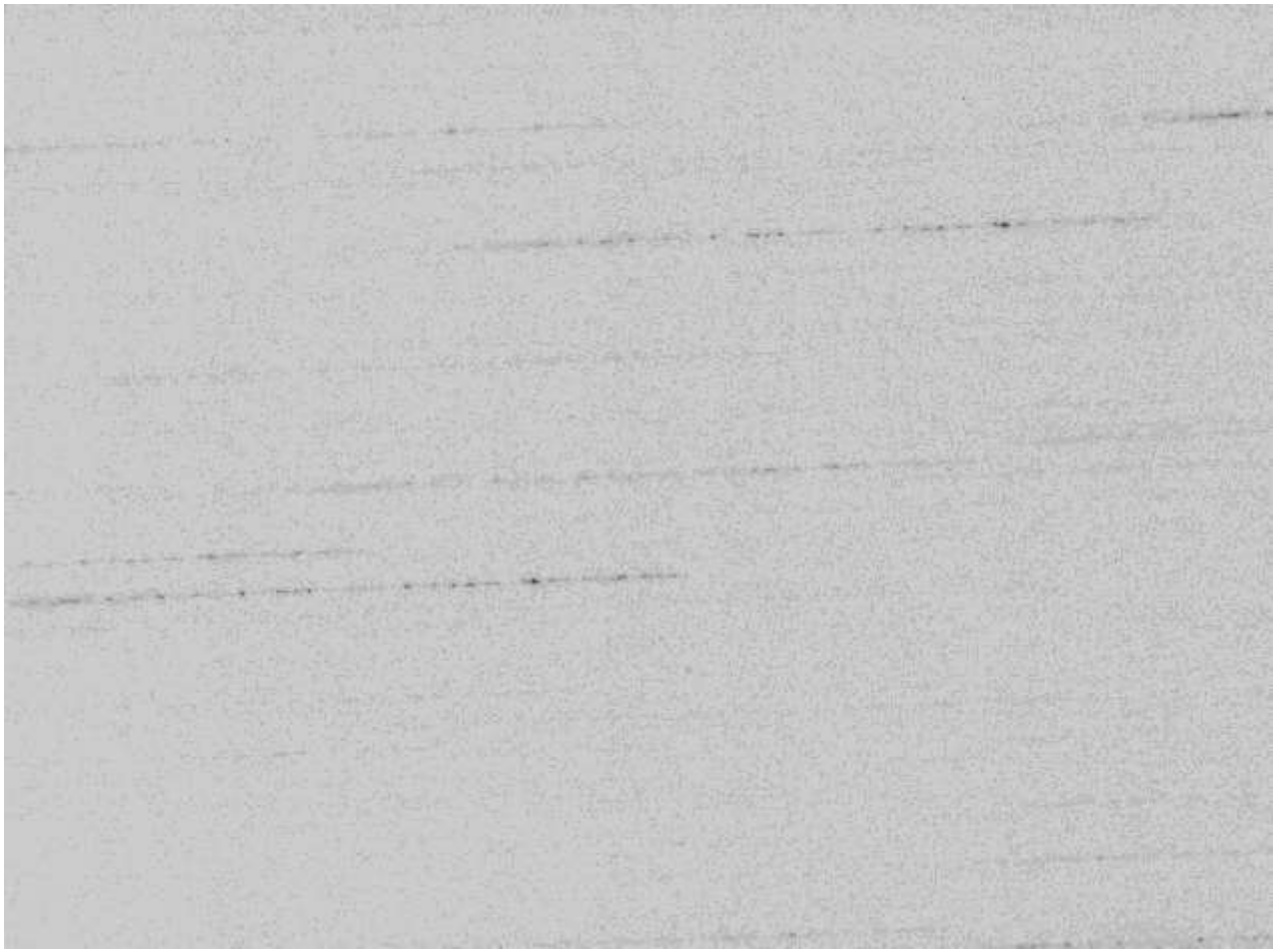
Mock-up of the adapter to TV-camera with pendulum mirror

Direct sky observations



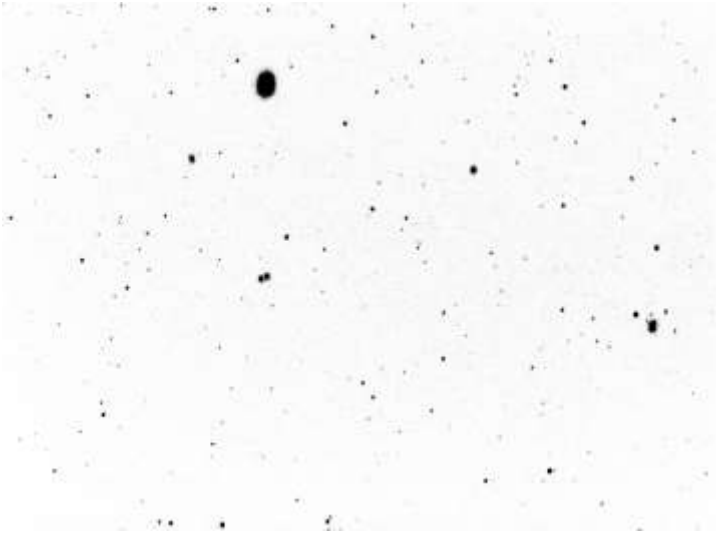
A camshot by TV camera on the base of matrix ICX285 with high speed lens Canon EF 85 mm f/1.2 at 1 sec exposition

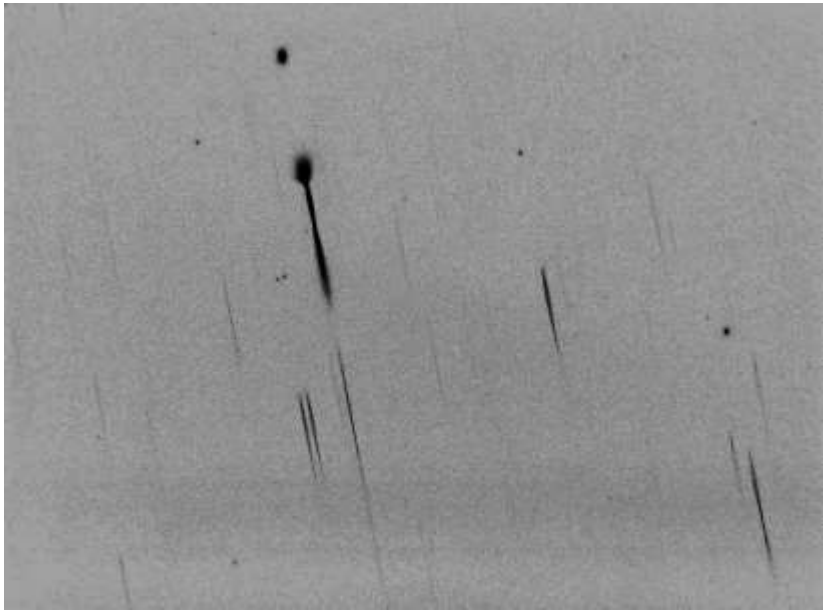
The same area with moving field of view



Even bright stars became hardly visible. It shows how may look a meteor with equal brightness at the same angular velosity

Spectral observations





Slit less spectrograph produces elongated images of point-like objects. If we achieve point-like meteor images of meteors with our adapter, we surely shall be able to have spectra of meteors about 7^m…8^m