Dark Matter – just dust?

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UNIVERSE IS DUSTY

Cosmic dust is present everywhere

Dust is one of the most fundamental constituents of the Universe

No dust – no stars – no planets – no us !

Dust:
- planetary (surface, atmosphere)
- interplanetary, circumstellar
- interstellar
- circumgalactic
- intergalactic

Cosmic dust – responsible for cosmochemistry

note:
H_2 molecule may originate effectively only on the surfaces of dust grains and it is crucial one for the whole cosmochemistry

Cosmic dust – responsible for FIR and MW background radiation (the alternative CBR source ?)

note: cosmic dust grains are very porous and fluffy structures, so as absorbers and emitters they may be treated as BBs)

note: cosmic dust temperature is most probably very close to 2.7 K (in general) and in some environments may reach values
10-100K (if transciently heated by close stars).

Extinction = dust tracer

Cosmic dust – responsible for light extinction

(the transparency of the Universe is limited mostly by dust)

Light extinction (A) is well known as one of important parameters standing in the Distance Moduli formula:

$$m - M = 5 \log r - 5 + A$$

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Even if we may evaluate correctly M, without exact knowledge of A we have no possibility to measure distances of celestial objects! Therefore, A should be well evaluated at the beginning of any astronomical considerations.

$A = A_{abs} + A_{scat}$

A_{abs} is relatively small – 1-2% of A $(A_{abs} << A_{scat})$

$A_{scat} = A(\lambda)$

Dust grains comparable in size with λ - Mie scattering, proportional to 1/λ,

For dust grain substantially larger then λ we have to deal with gray extinction, independent on λ.

Strong selection effect!!!

Mie scattering → reddening (relatively easy to evaluate) → colour excess →
→ extinction curve → parameter R → extinction (given by grains comparable in size with λ)

Grey scattering → no reddening → „hidden extinction” (= very difficult to be detected)

Dust contribution to the DM

small grains (with big A/M ratio) → contribute weekly to overall mass of DM

bigger grains (with small A/M ratio) → may contribute very much!

Note:
Mass unit divided into small grains gives big extinction.
Mass unit divided into big grains gives low extinction.

Greater grains produce given extinction, greater (linearly) dust density of the environment (greater dust contribution to DM)
Even if one knows extinction to given source, one can not to evaluate mass of dust causing this extinction.

Example I: (distance and extinction)

$$m - M = 5 \log r - 5 + A \quad \rightarrow \quad r_o/r(A) = 10^{0.2\,A}$$

(r_o - in assumption of no extinction)

$A=1 \rightarrow r_o/r(A) = 1.58$

$A=2 \rightarrow r_o/r(A) = 2.51$

$A=3 \rightarrow r_o/r(A) = 3.98$

$A=4 \rightarrow r_o/r(A) = 6.31$

$A=5 \rightarrow r_o/r(A) = 10$

(greater extinction → real distances lower)

Example II: (SN Ia and extinction)

Officialy announced observation – distant SN Ia (at $z \approx 1$) are 15-25 % fainter than closer SN Ia (at $z < 0.1$).
Official interpretation – acceleration of the Universe, dark energy

But:

This observation may be quite well explained by assuming tiny light extinction 0.2 – 0.3mag on the distance of about 6 GLY

Conclusions and open questions::

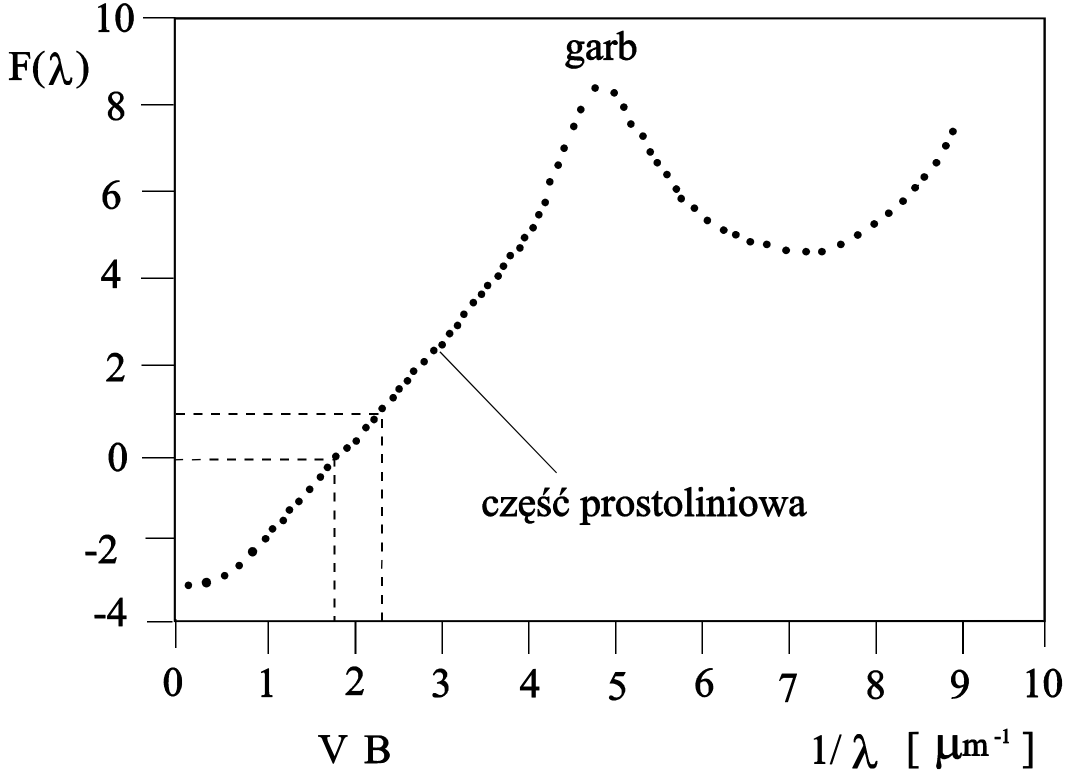
The problem of the transparency of the Universe semms to be fully ignored by astrophysicists.

Size distribution function for dust grains is of very great importance and it is still to be find.

May the cosmic dust be the main DM constituent?

May cold cosmic dust explain observed CBR?

Extinction curve: $F(\lambda) = E(\lambda,V) / E(B,V)$



Parameter R

$$\lim_{\lambda \to \infty} F(\lambda) = \lim_{\lambda \to \infty} (A_\lambda - A_V)/(A_B - A_V) = -A_V/(A_B - A_V) = -R$$

$\rightarrow \quad A_V = R\,(A_B - A_V) \approx 3.1\, E(B,V)$

Important formulae for dust and extinction

τ(optical depths) = 2/3 $\ln(n_o/n)$ ($A = 1.086\ \tau$)

ρ(dust density) = $(\tau\ V_g\ s)/(QD\sigma_{geom})$ ($V_g/\sigma_{geom} \sim r_z$)

where: s – grain density, V_g – grain volume, Q – effective extinction coefficient ($Q(\lambda) = \sigma_{eff}(\lambda) / \sigma_{geom}$), D – dust cloud thicknees