Developing students' creativity by interplay of alternatives.

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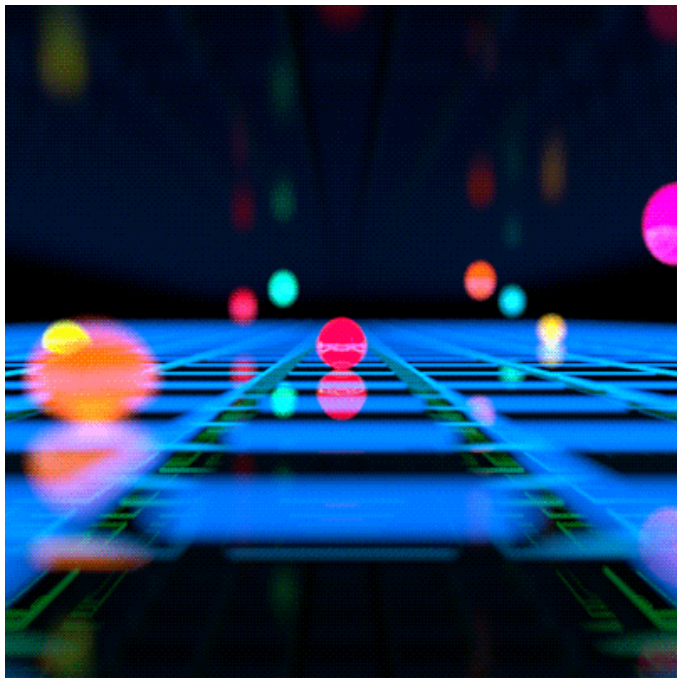
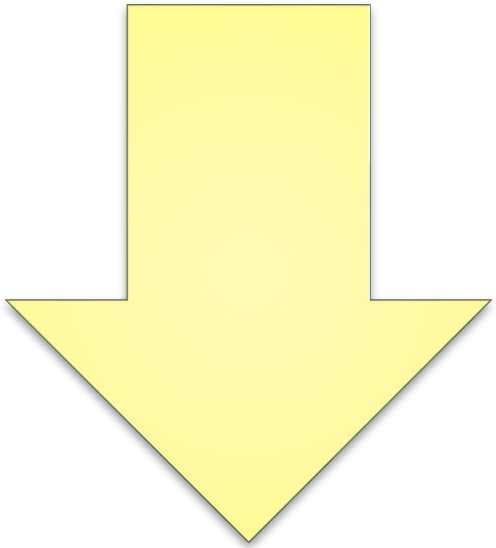
The dynamical stability is realized through the interaction and balance of different and even alternative factors and approaches.





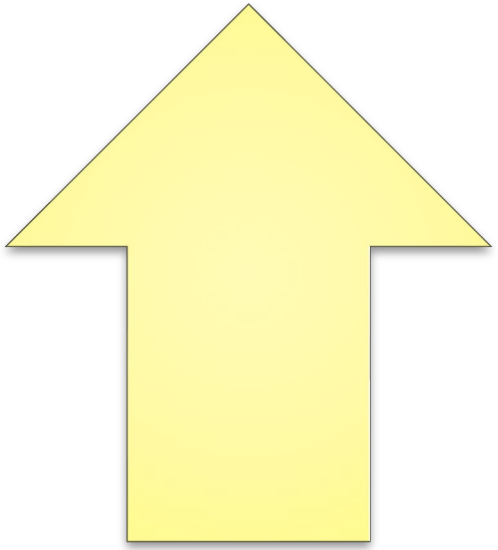
- Laws
- System of "rules"
- Canonical methods

Science

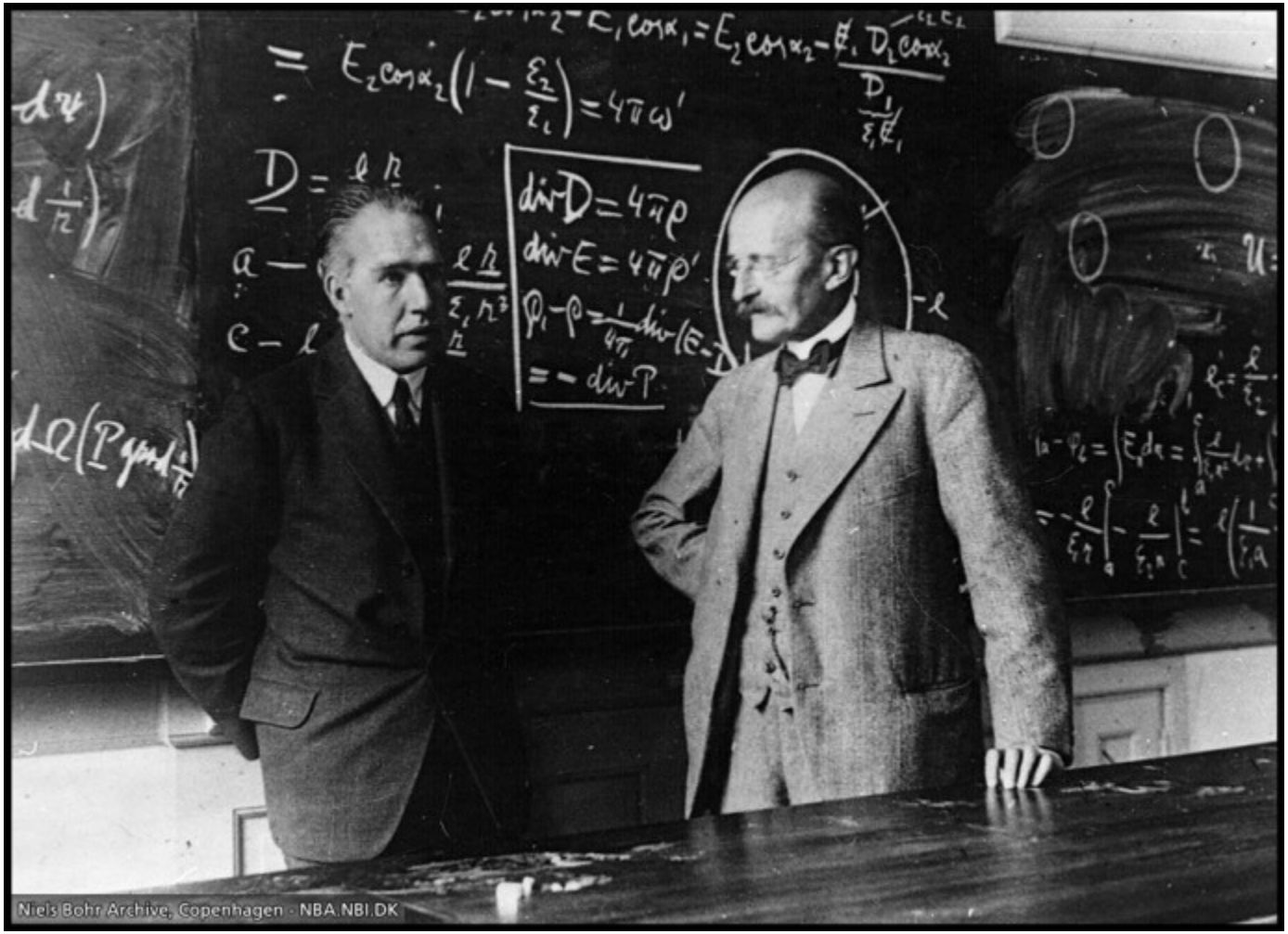
Interplay of ideas

"Moment of doubtness"

Alternative vision



What is “scientific methods”?



Participants

- STEM – cluster of additional education in Karelia Republic;
- School's students of Karelia Republic
- Students from Petrozavodsk State University and
- School's teachers
- University teachers

The task

To measure the tree height

To measurer something means to compare it with some reference standard

- Direct measurements of height;
- Modified "height's measurements";
- Indirect measurements (height through velocity, time, age);
- Statistical survey

Direct measurements

$H_{student}$=1,83 m

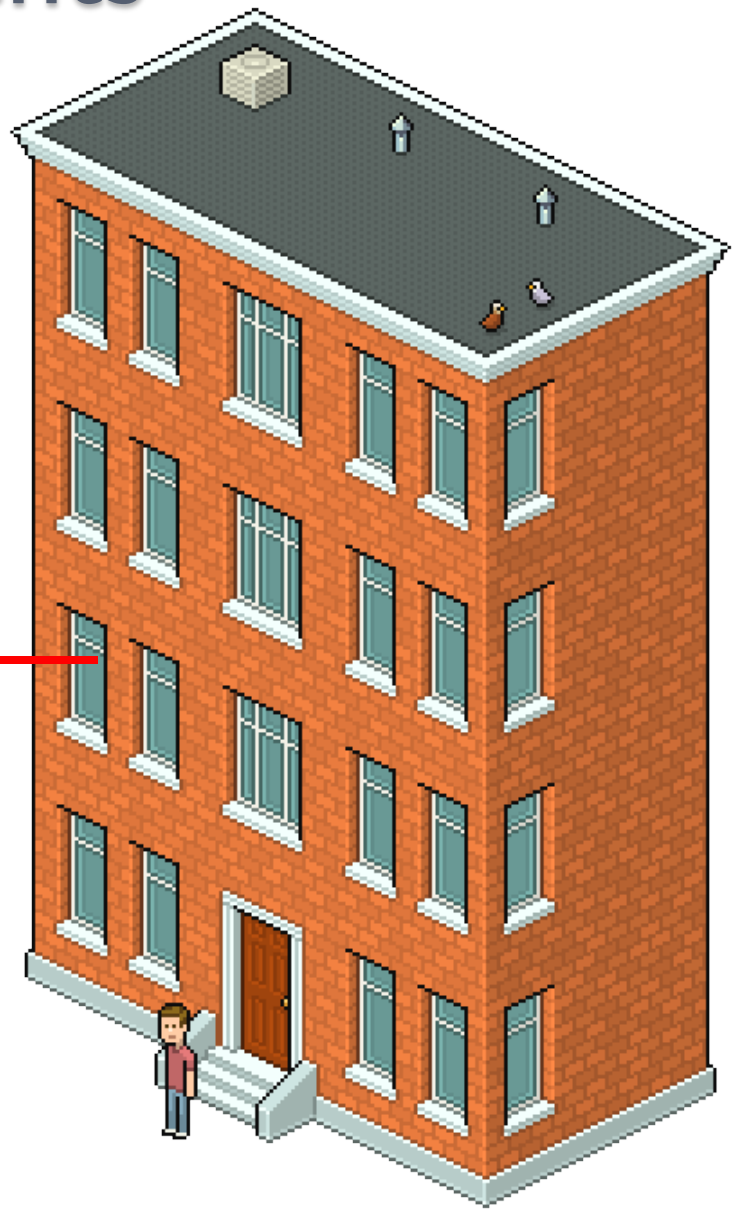
H_{pine}=5,00 m

Direct measurements

H=5,10 m

Direct measurements

H=5,50 m



Direct measurements

H=5,13 m

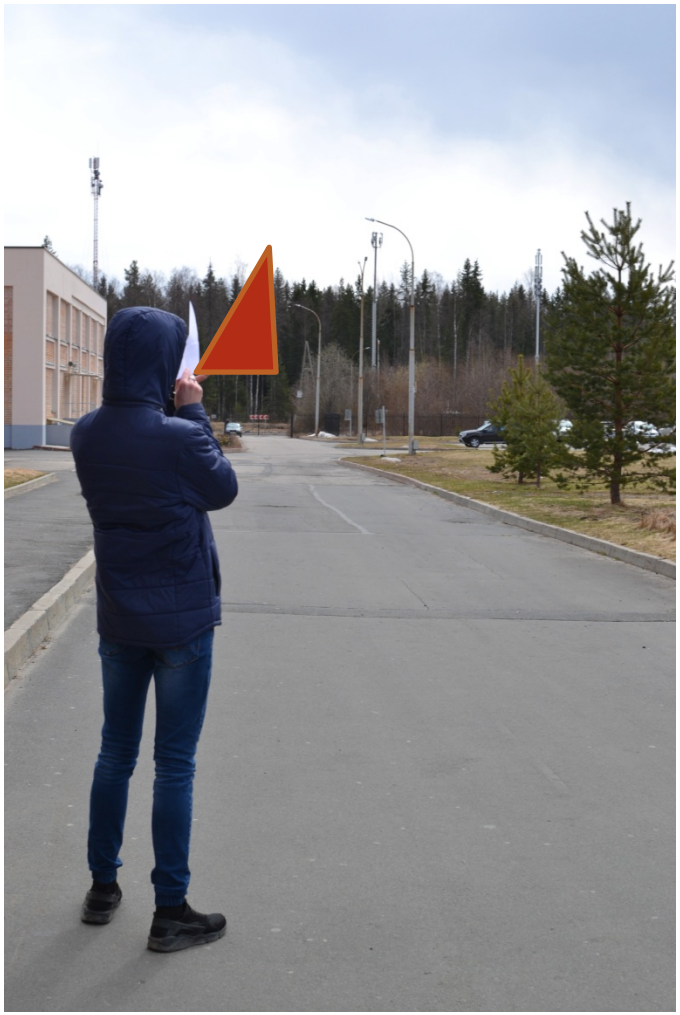
Modification of direct measurements

H=4,80 m

Modification of direct measurements

H=5,14 m

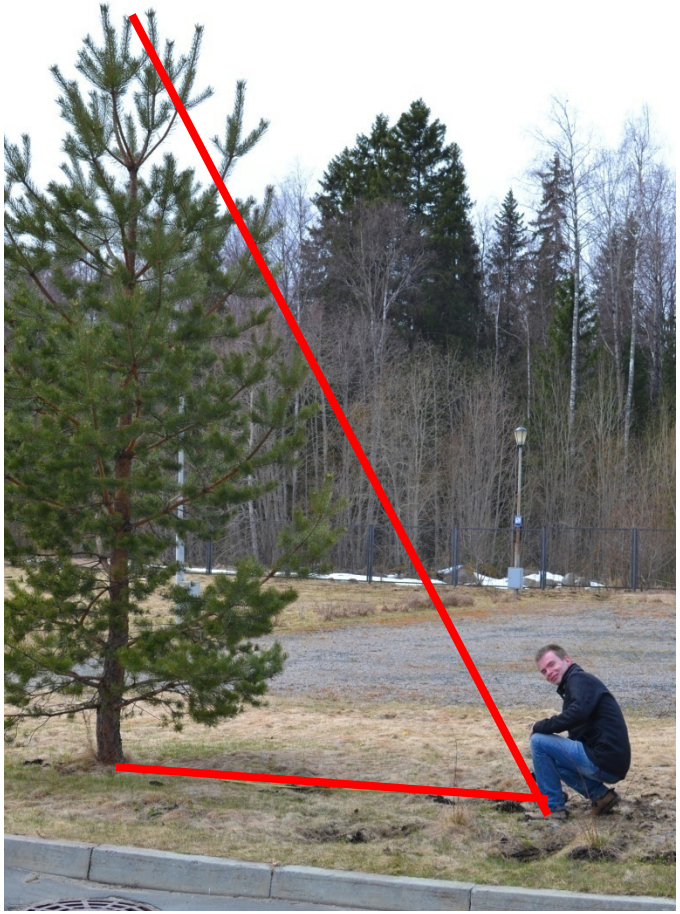
Modification of direct measurements



H=5,12 m

Modification of direct measurements

H=5,14 m



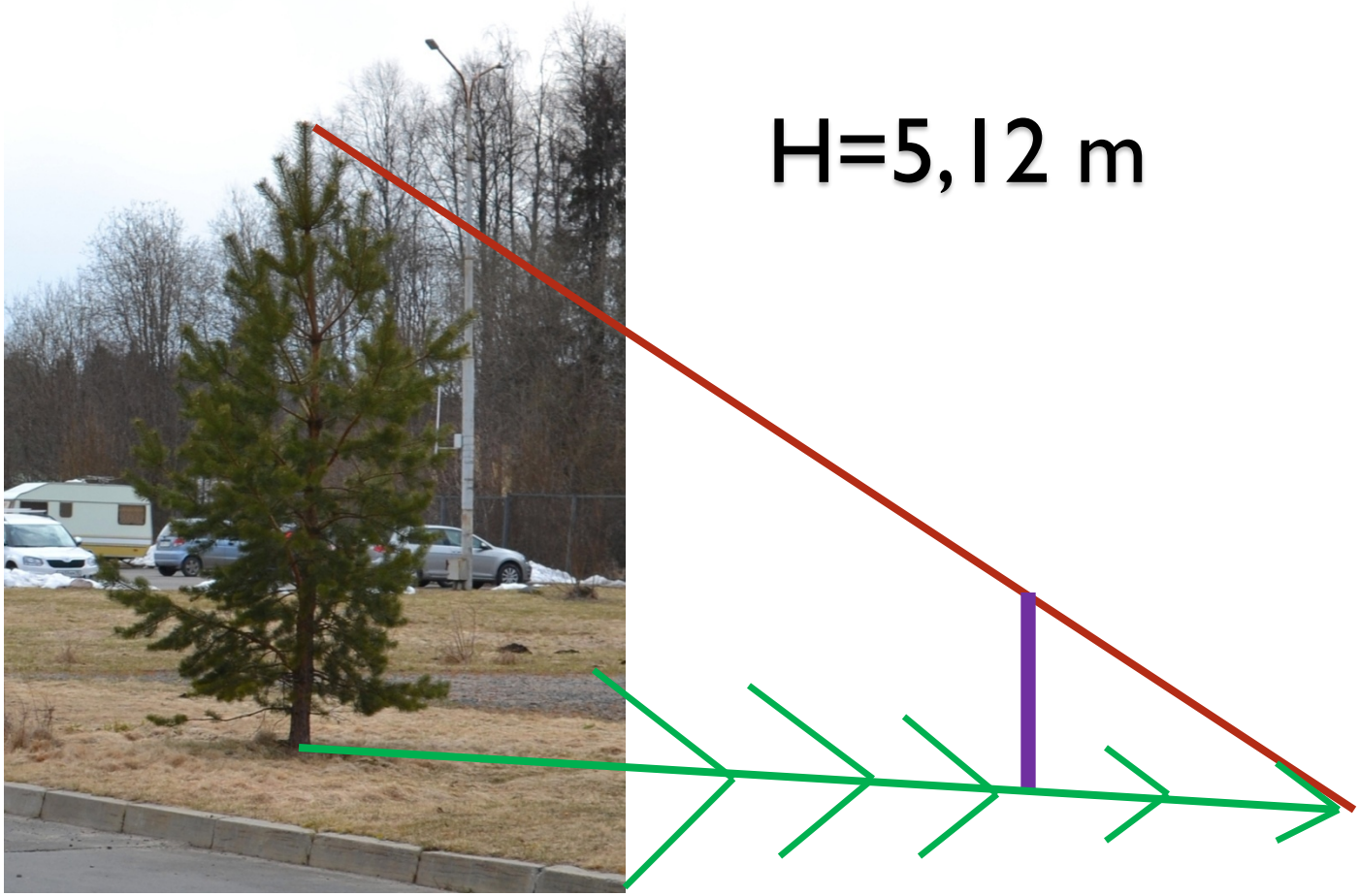
Modification of direct measurements

H=5,40 m

Modification of direct measurements

H=5,14 m

Modification of direct measurements



Indirect measurements

$$H = \frac{gt^2}{2}$$

H=5,02 m

Indirect measurements

$$H = \frac{gt^2}{8}$$

H=5,04 m

Indirect measurements

$$V = \frac{S}{t}$$

$$S = Vt$$

H=5,09 m

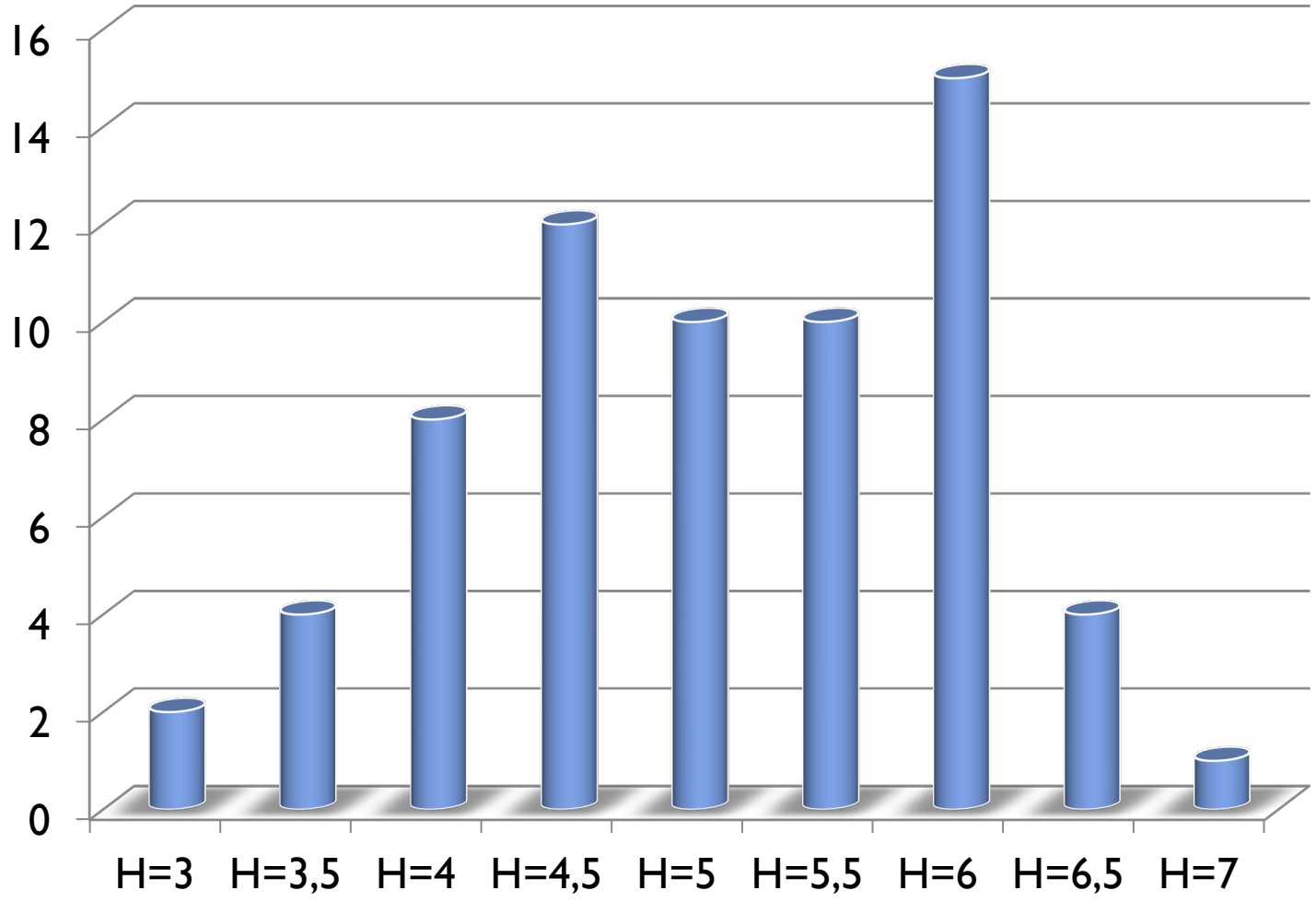
Indirect measurements

$$age = k \cdot d$$

$$H = 5 \div 6\, m$$

Statistical survey

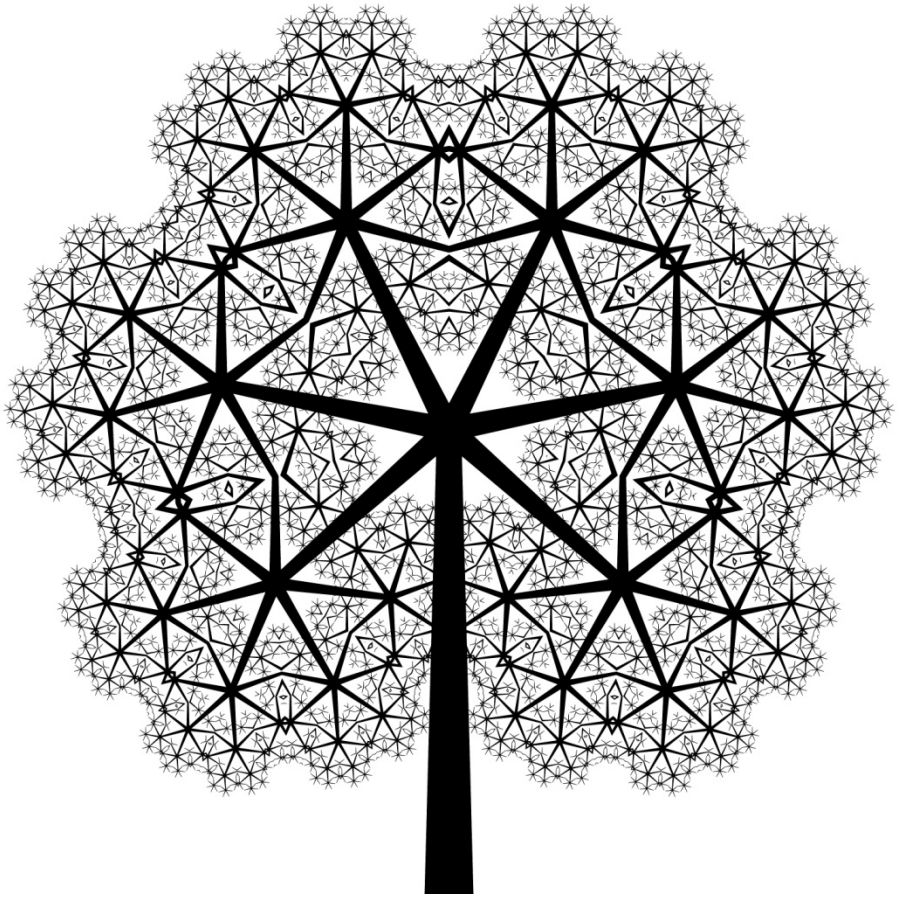
H=4,91 m

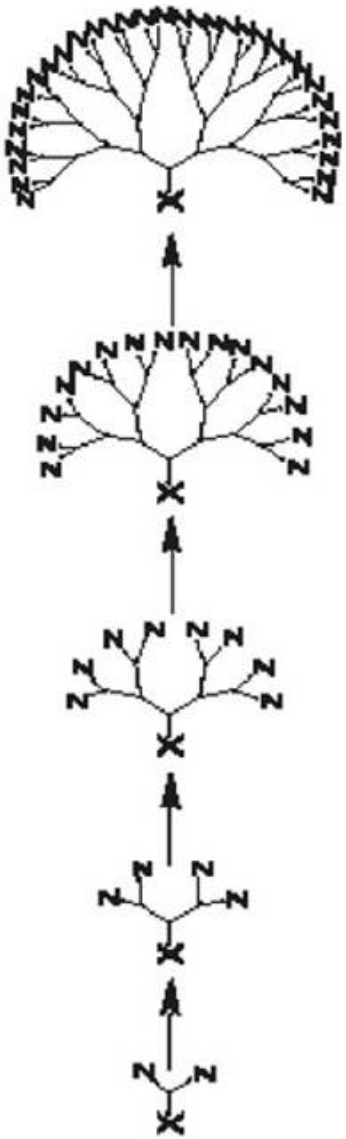


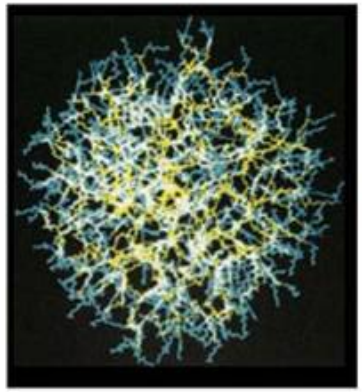
The number of pine needles

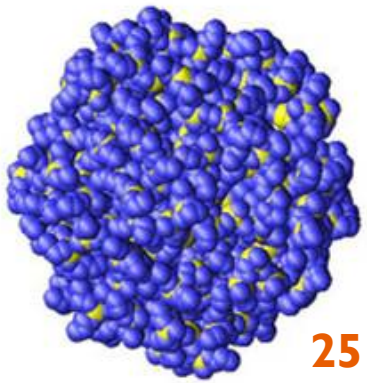
- Statistic survey;
- To count the number on one unbranched twig and then multiply by number of twigs;
- To find out average value for ten (?) twigs and the multiply by its numbers;
- To find out the volume of the tree, then reduce it in N (?) times and divide for volume of one needle.

From simple objects to Big Physics









Conclusions

- These cases are open-ended, really stimulating students' creativity;
- Interplay of students' alternative ideas;
- Deriving new dimensions of school and university students and teacher interaction;
- The objects under investigation are ordinary available, special equipments or devices are not necessary;
- We don't need special laboratories and rooms; outdoors environment is mostly enough;
- The cases are not artificial; each of them appears from the pure natural phenomenon or process;
- From simple objects to Big Physics.

Thank you!