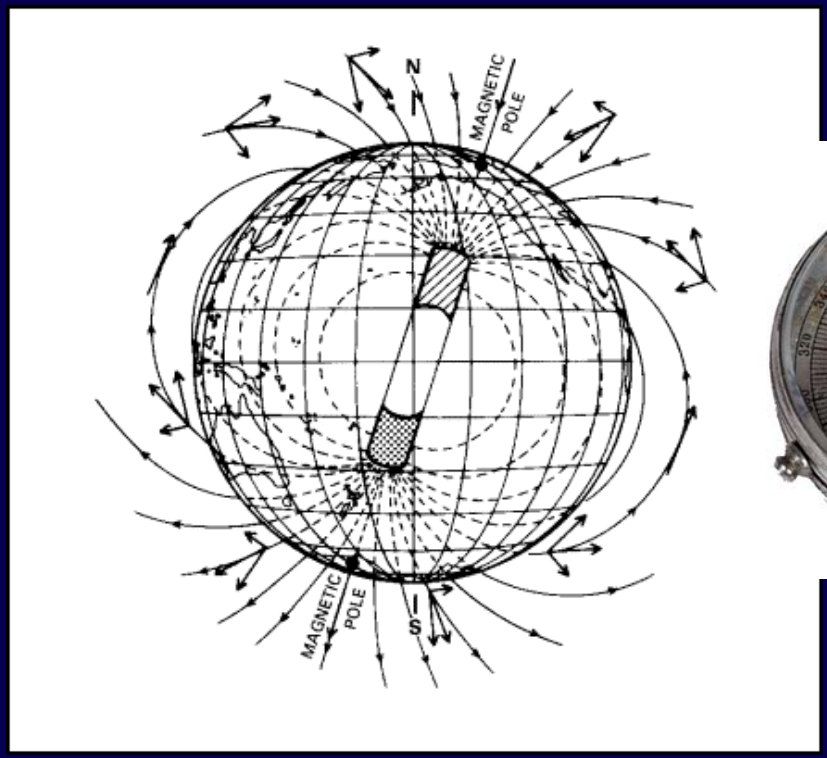
16- Small Fields



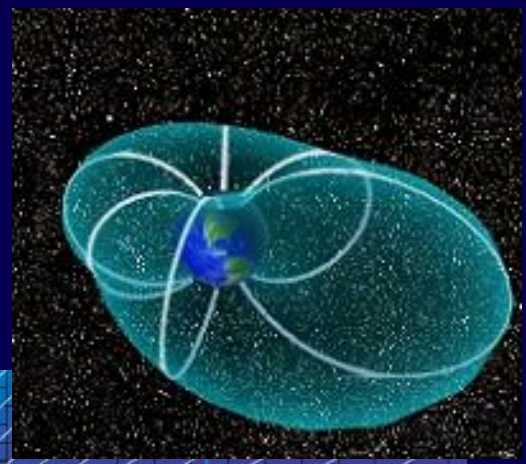
16. Small Fields

Construct a device based on a compass needle to measure the Earth`s Magnetic Field.

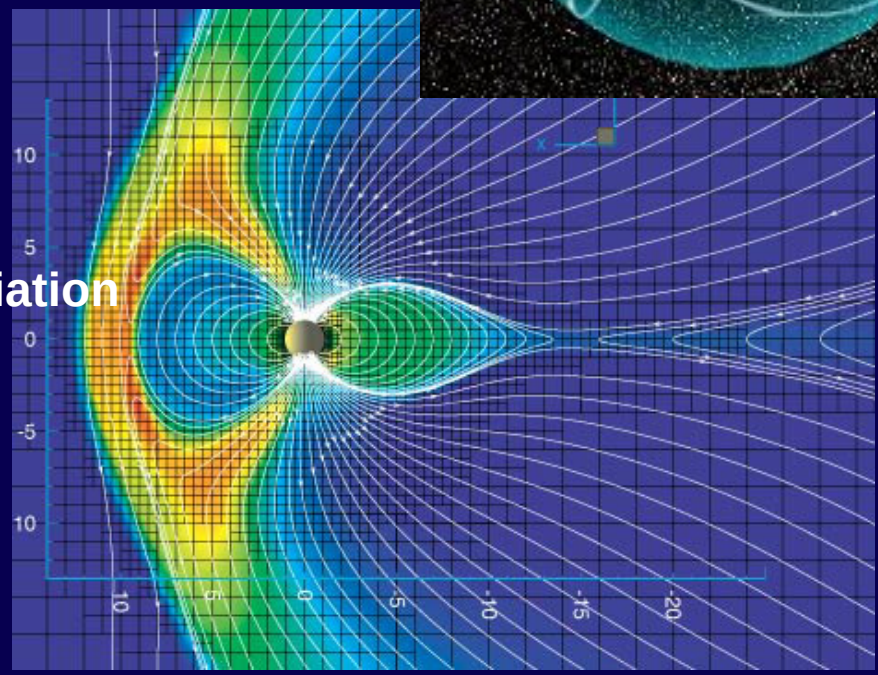
By Aron Alexandre Heleodoro

16- Small Fields

Introduction



- **The importance**
  - **Superficial**
  - **Exterior Field (Van Allen Belt)**



- **How to measure it**
  - **Using the magnetic needle deviation**
  - **Using the charge deviation**
  - **Using a rotating coil**

16- Small Fields

The Method

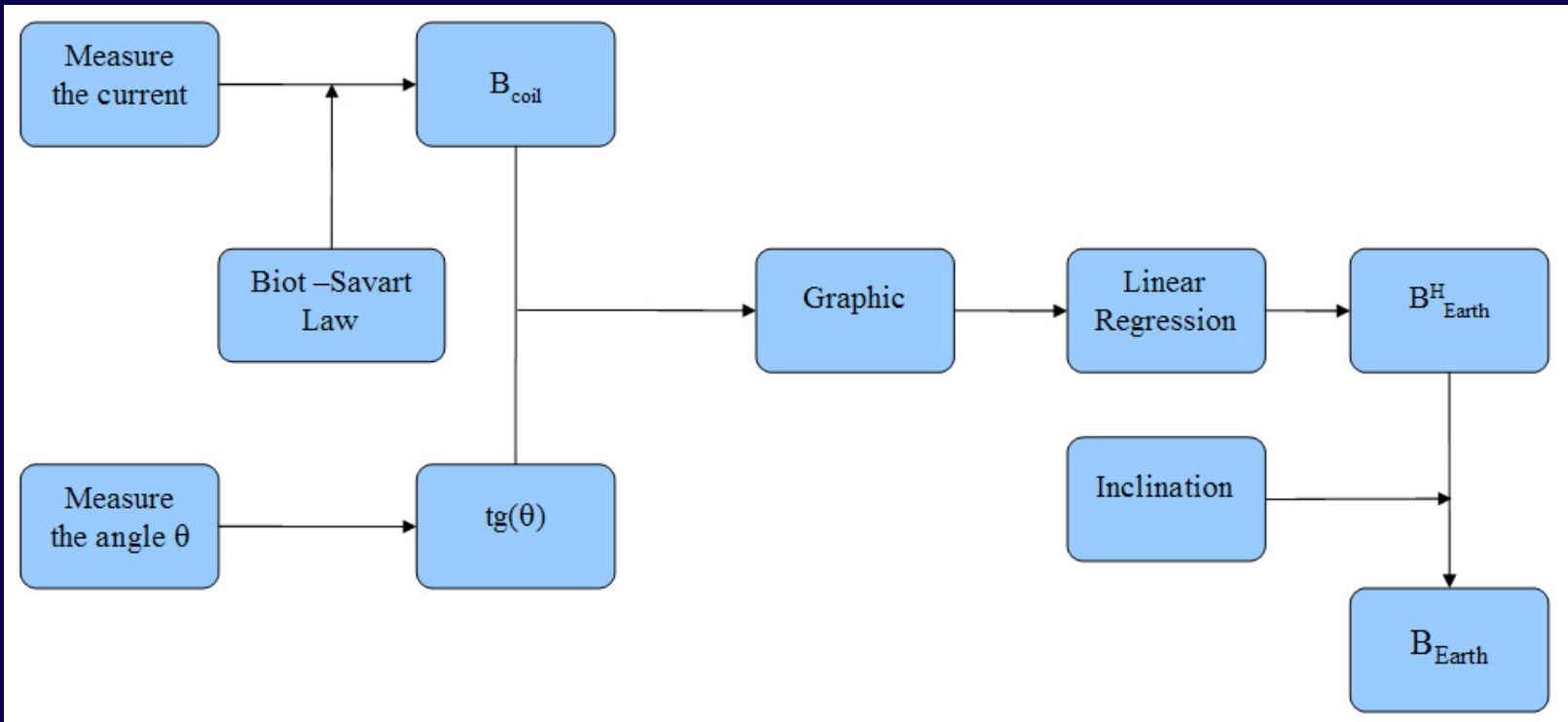
- ❖ **Mathematical Model**
  - ➢ **Vectorial sum of two fields**
    - **#1: Earth's Magnetic Field**
    - **#2: A field of known intensity and direction**
  - ➢ **Biot-Savart Law**
    - **Intensity and direction the magnetic field in a coil**

✓ **Linear relation between the current in a coil and the tangent of the deflection angle.**

- ❖ **Practice**
  - ➢ **Electric Circuit**
  - ➢ **Data acquisition (current and deflection angle)**
  - ➢ **Linear regression**
  - ➢ **Final value of the Earth's magnetic field**

16- Small Fields

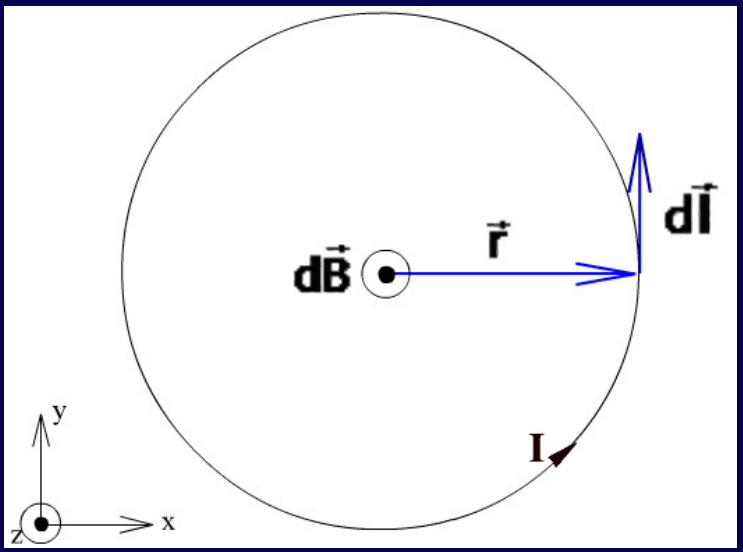
The Method

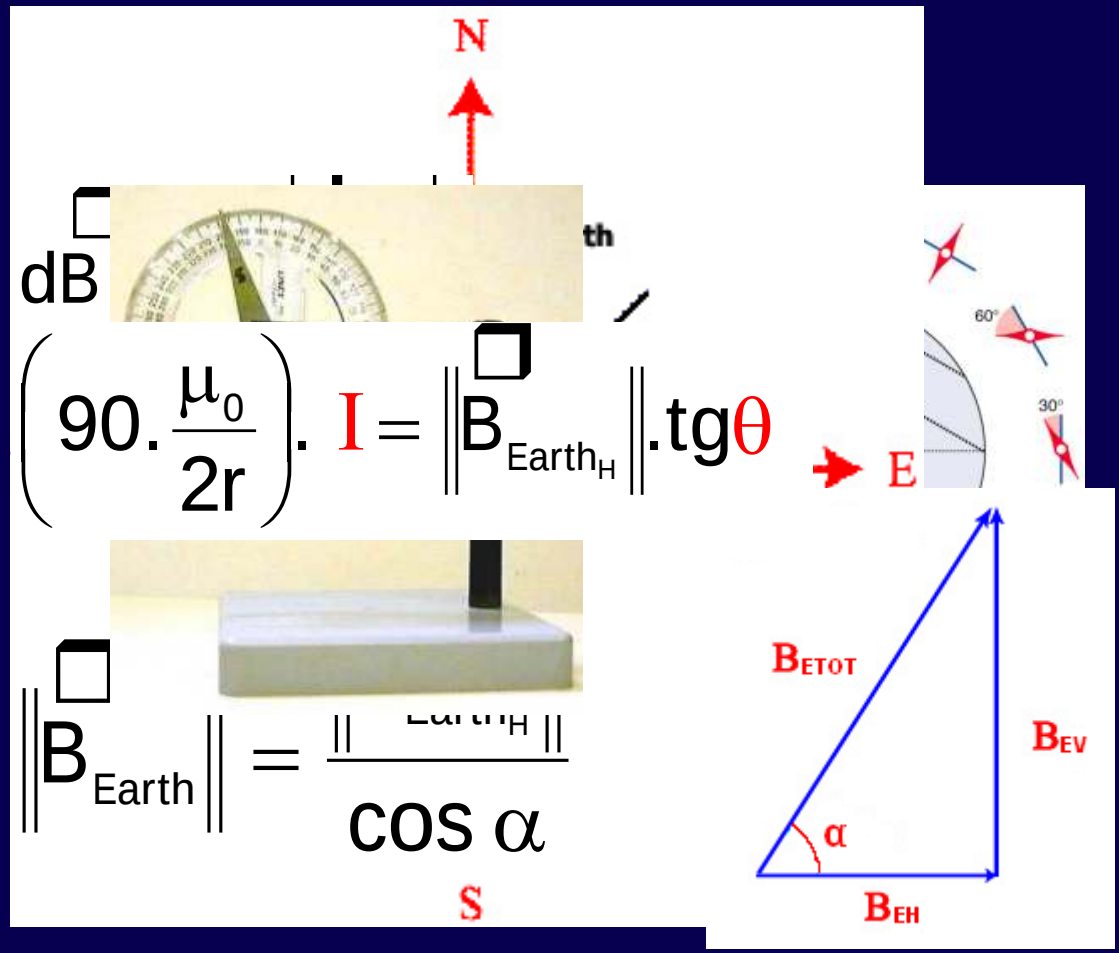


16- Small Fields

Development - Theory

- Deviation
- Biot-Savart Law

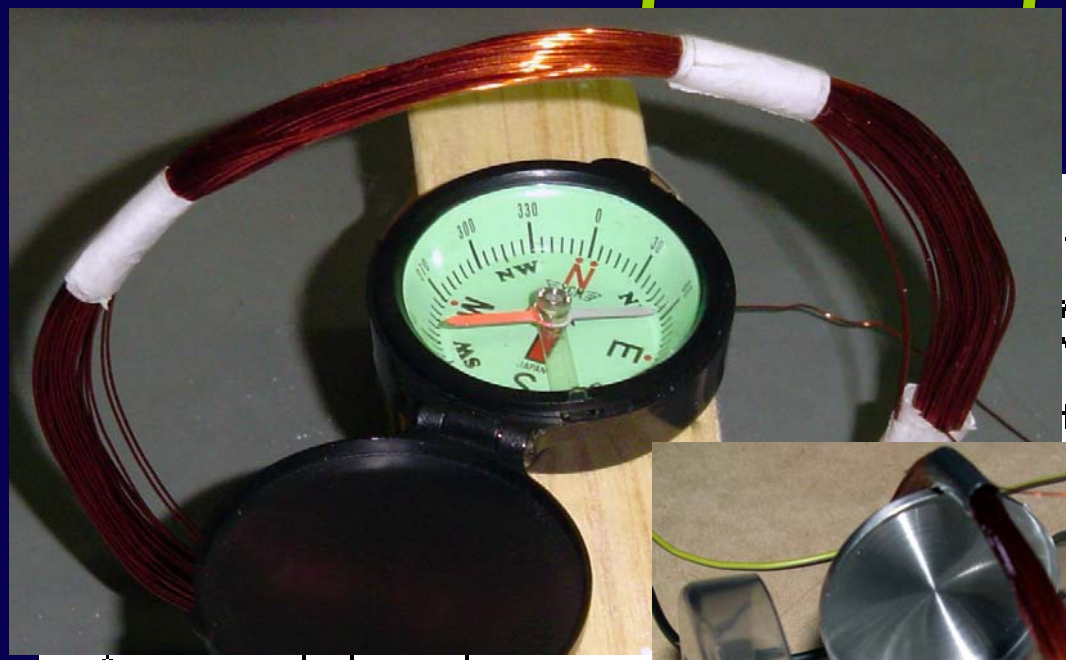


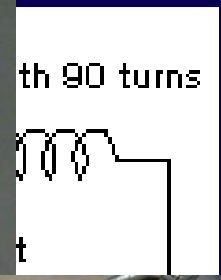


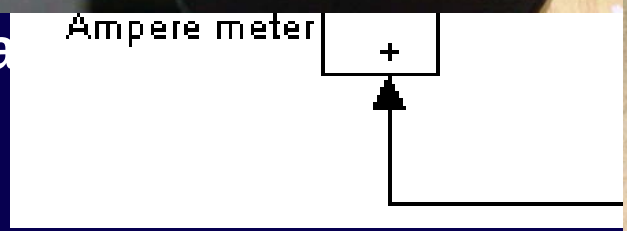
16- Small Fields

Development - Experiment

- Materials
- Set up
- Collected Data







16- Small Fields

Development - Experiment

- Photos
- Video

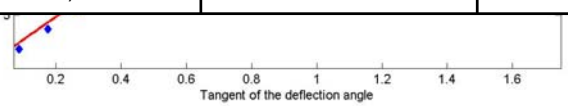
16- Small Fields

Development - Data Analysis

- Tables
- Graphics
- Final Result

Table of Data (increase of current)

Current (I) [mA]	Angle (θ) [°]	tg θ	Magnetic Field of the Coil (B_{coil}) [μT]	Horizontal component of the Earth's Magnetic Field (B_{EarthH}) [μT]
1,6	5	0,087	1,645	18,803
2,8	10	0,176	2,878	16,326
4,8	15	0,268	4,935	18,418
8,2	20	0,364	8,430	23,163
12,0	25	0,466	12,337	26,458
15,0	30	0,577	15,422	26,712
17,0	35	0,700	17,478	24,962
19,0	40	0,839	19,534	23,281
21,0	45	1,000	21,591	21,591
25,0	50	1,192	27,703	21,568
29,0	55	1,428	29,816	20,877
32,0	60	1,732	32,901	18,995



leflection angle

16- Small Fields

Experiment - Error Sources

- Other Magnetic Sources and interference in the Net Field
- The Geometry of the model
  - Magnetic needle is an extensive body
  - Geometric center of the coil
- Imprecisions in the measurement of the angle and current
- Friction in the magnetic needle
- Parallaxes

16- Small Fields

Conclusion

- **Comparison with a theoretical value**

$\left\| \vec{B}_{ET} \right\| = 23{,}18\ \mu T$

$\left\| \vec{B}_{ET} \right\| = 23\ \mu T$

$\left\| \vec{B}_{ET} \right\| = 24{,}46\ \mu T$

- **Good theoretical model**