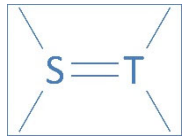




POLITECNICO
MILANO 1863



Lab. di sperimentazione
didattica ST2

Forza ed eleganza del magnetismo

Maurizio Zani

Corso di orientamento, Politecnico di Milano

Juri Chechi, il signore degli anelli



L'esercizio perfetto, Olimpiadi di Atlanta, 1996

Il metodo



Realizzazione

Jade Belt Bridge (Beijing, China)



Progetto



Squadra

The 3 rules of learning



Realizzazione

Apprendimento (ovunque)

1. Learning is an experience, not a download
 - Involve the students in the learning approach; they must be engaged in the experience
2. Learning happens everywhere & everytime
 - Open your fantasy, evaluating what may be the best way to reach the learning goals
3. Learning takes care of materials & methods
 - Choice the appropriate combination, in order to make learning achievements more effective

<http://www.mauriziozani.it/wp/?p=6473>

credits voce femminile: Lucia Ganzer

Fisica

- fino al 1600: filosofia naturale (perché la natura si comporta così, opinioni)
- dal XVII secolo (Galilei): scienza (come la natura si comporta, misure)

Scienze

- **scienze naturali** (studiano fenomeni materiali: fisica, chimica...)
- **scienze sociali** (studiano interazioni sociali: psicologia, storia...)

Scienza

- come si studia (**metodo sperimentale**)
- cosa si studia (**grandezze fisiche**)
- come si descrive (**matematica**)

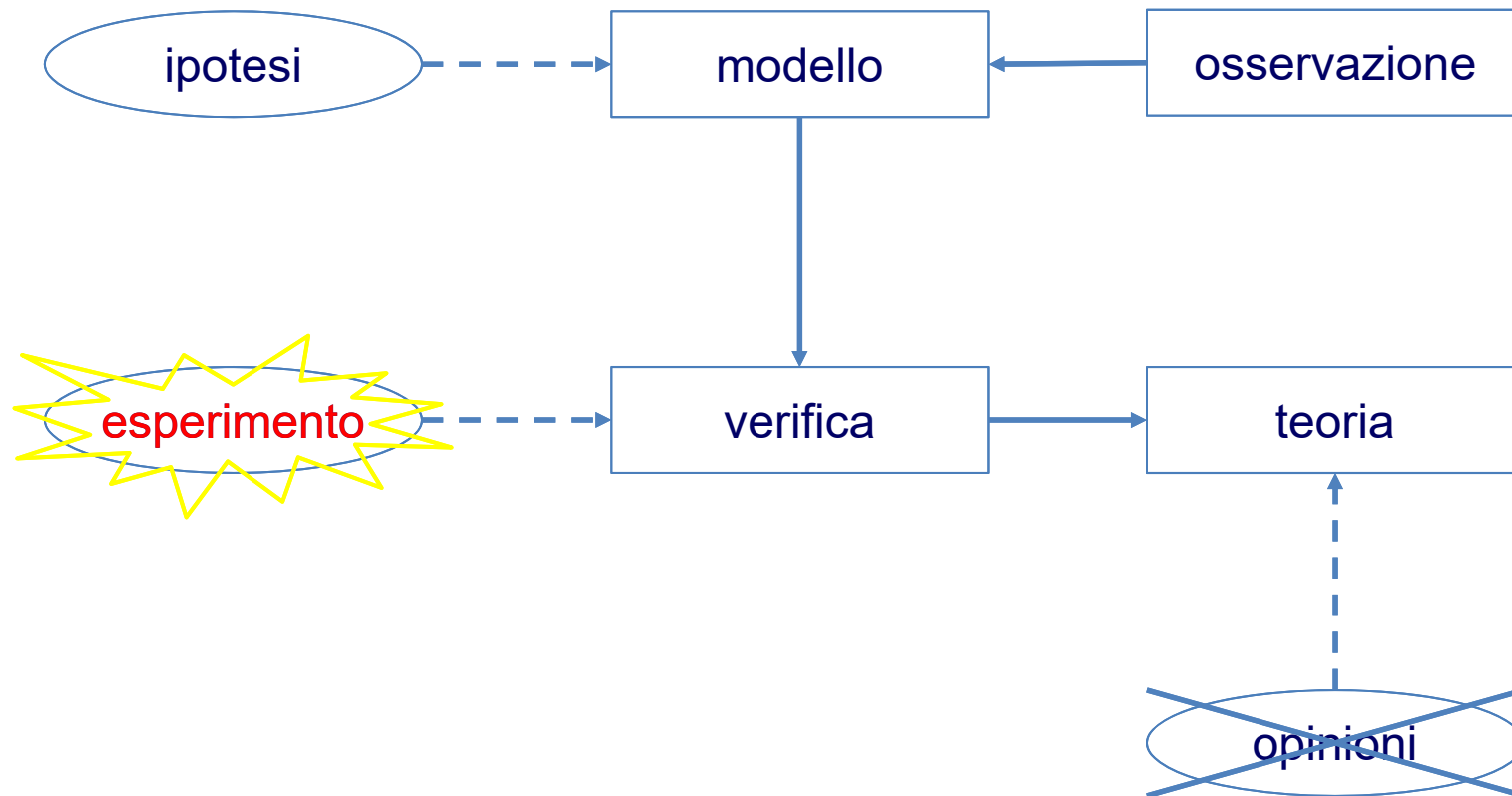
Fisica classica (legata alle sensazioni umane)

- meccanica: fisica del moto
- gravitazione: fisica planetaria
- termodinamica: fisica del calore
- acustica: fisica del suono
- ottica: fisica della luce
- elettromagnetismo: fisica della radiazione

Fisica moderna (rientra nella precedente per condizioni classiche dei parametri)

- fisica relativistica: alte velocità (velocità della luce)
- fisica quantistica: basse dimensioni (costante di Planck)
- fisica atomica: intimo della materia (elettroni, protoni, neutroni)

Il metodo sperimentale



Le 3 regole per studiare fisica

1. La fisica non è la matematica

- Prima la comprensione del fenomeno, poi la sua descrizione analitica

2. Gli argomenti trattati si studiano sui libri

- Non solo sui propri appunti, né su quelli dei compagni

3. Non c'è scritto da nessuna parte che la fisica sia noiosa, lasciatevi stupire

- Enjoy! A studiarla e a insegnarla...

<http://www.mauriziozani.it/wp/?p=3635>

Le 3 regole per insegnare fisica

1. La fisica non è la matematica

- Prima la presentazione del fenomeno, poi la sua formalizzazione analitica

2. Il docente non è un libro di testo

- Serve trasmettere anche la passione, non solo le nozioni

3. Insegna argomenti che non chiederai all'esame

- La curiosità è tutto, talvolta si deve essere imprevedibili...

<http://www.mauriziozani.it/wp/?p=4884>

Il magnetismo

LE GRANDI RACCOLTE PER LA GIOVENTU'



MAGNETO

a cura di Maurizio Zani



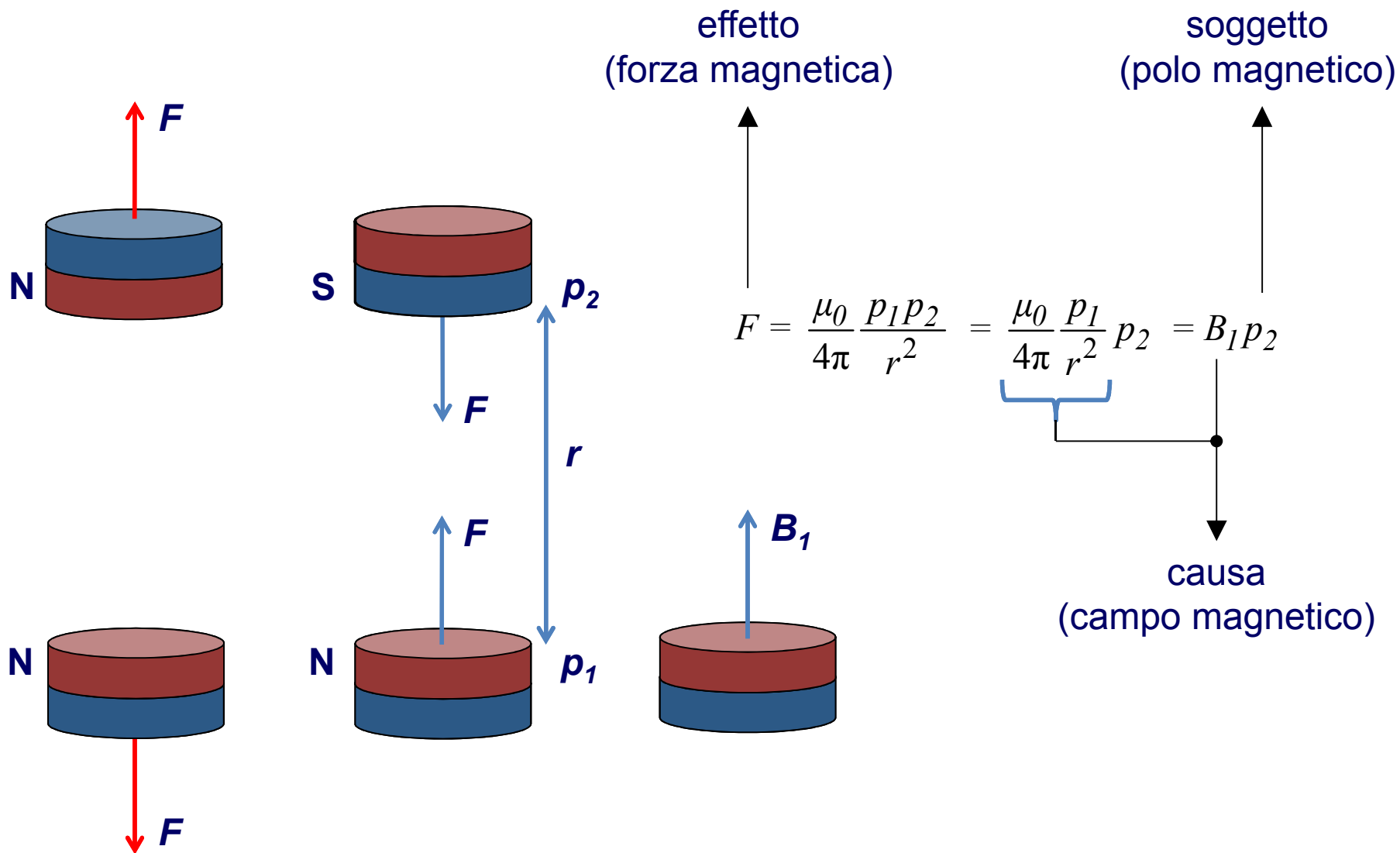
Nelle migliori edicole...



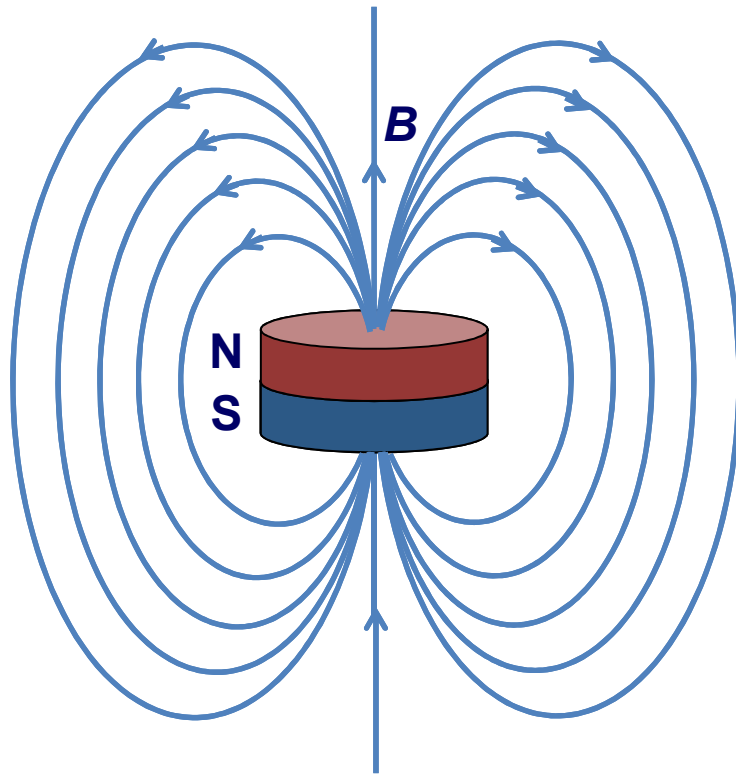
Magneto in «X-Men»

campi magnetici
antigravità

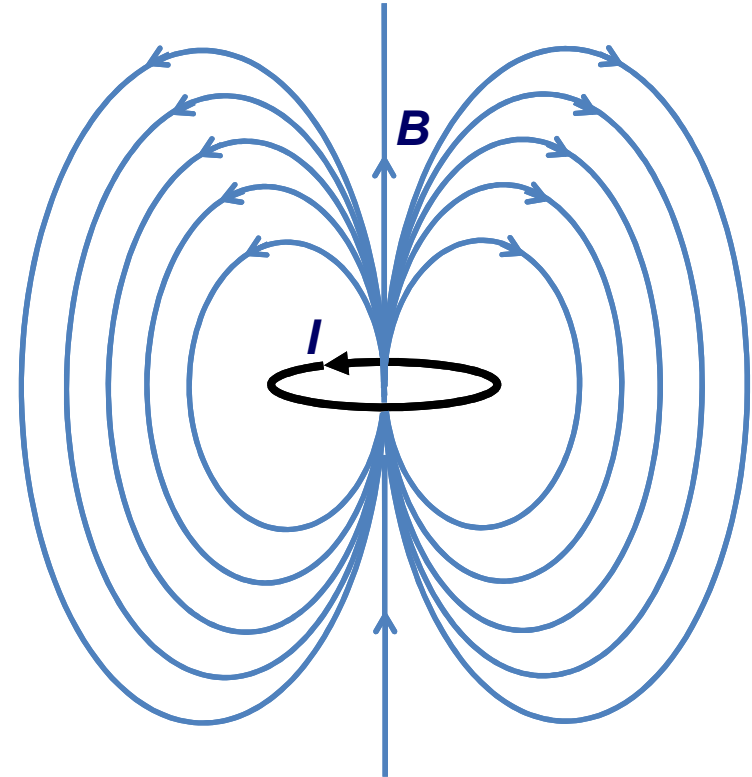
levitazione magnetica



teorema di equivalenza di Ampère

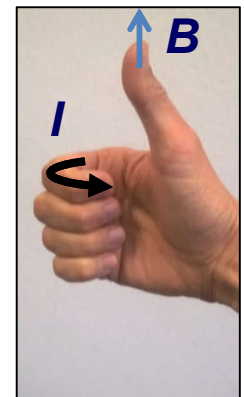


magnete

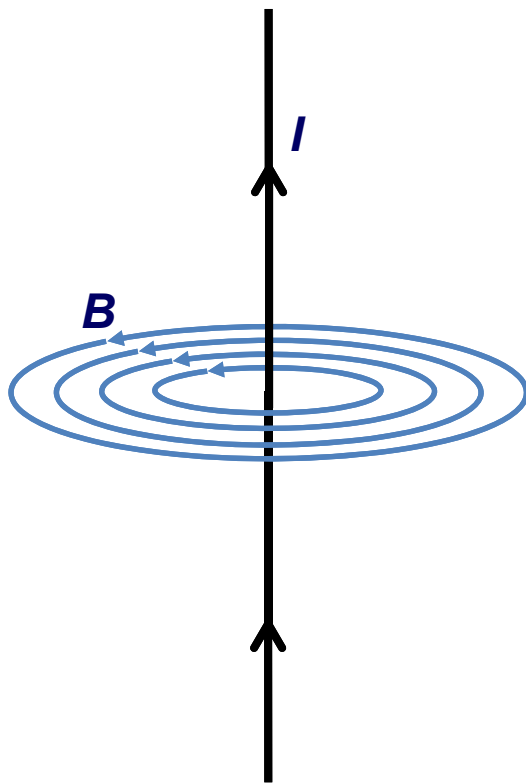


spira

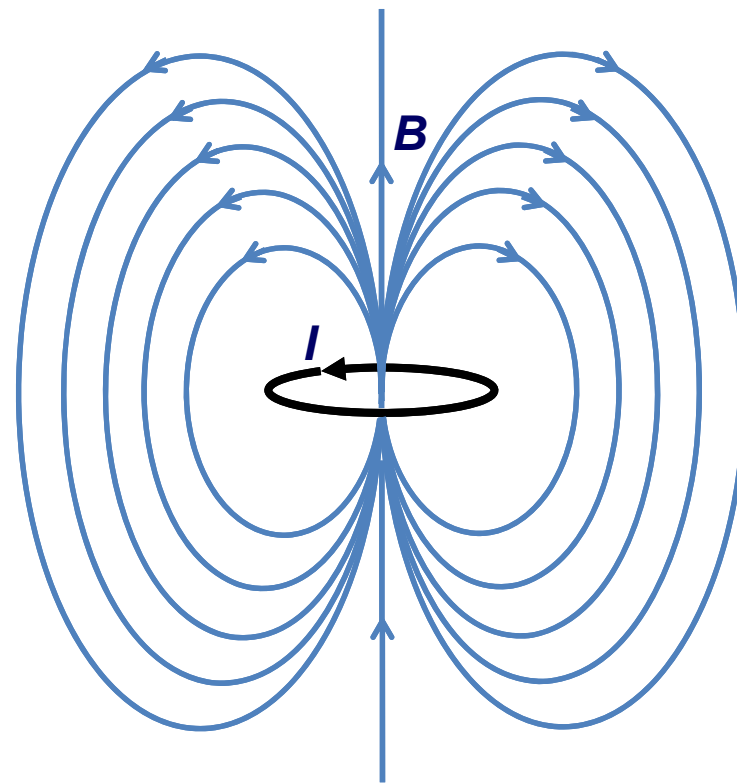
regola
della mano destra



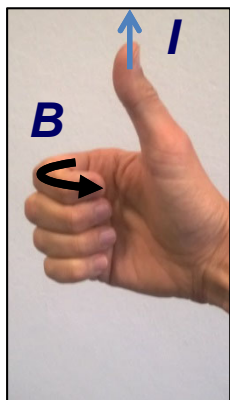
legge di Biot-Savart



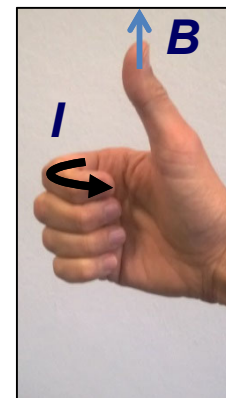
filo rettilineo



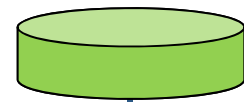
spira



regola della mano destra



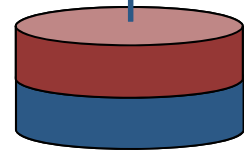
ferromagnete



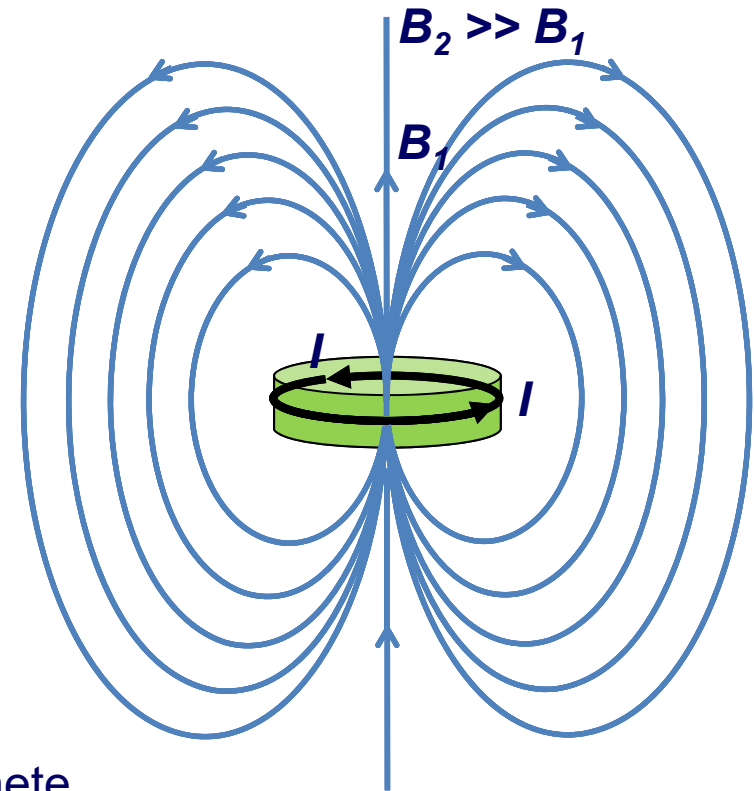
$B_2 \gg B_1$

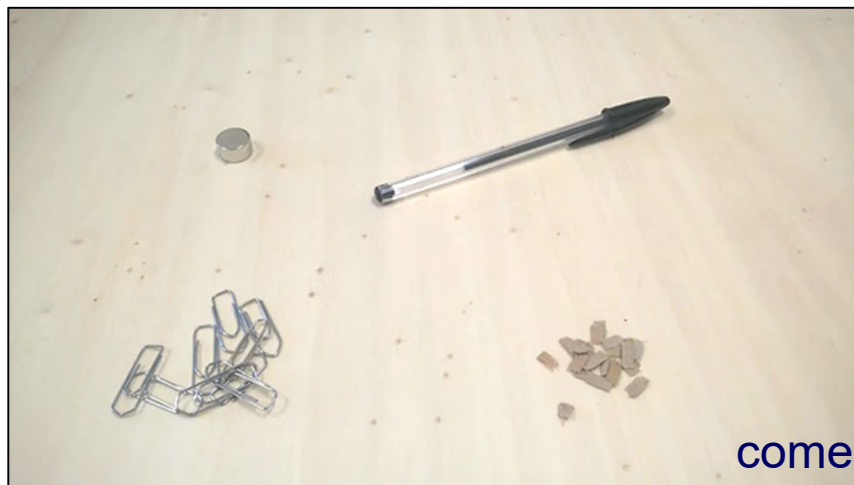
B_1

magnete



elettromagnete



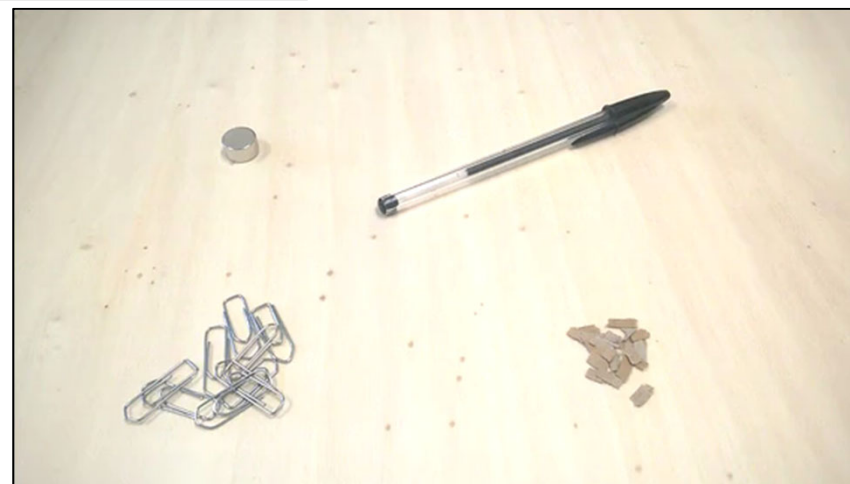


magnetizzazione

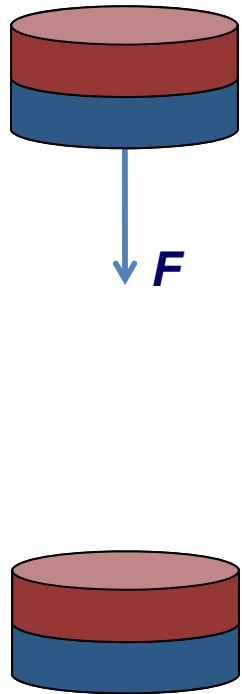


polarizzazione

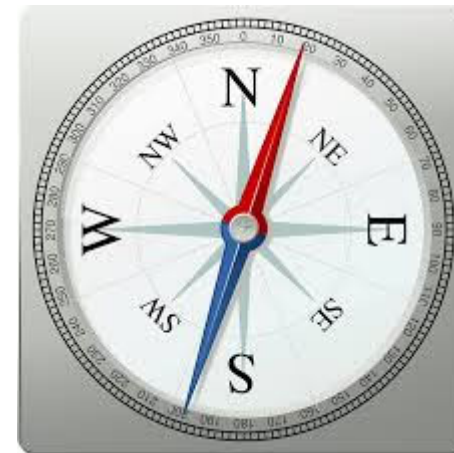
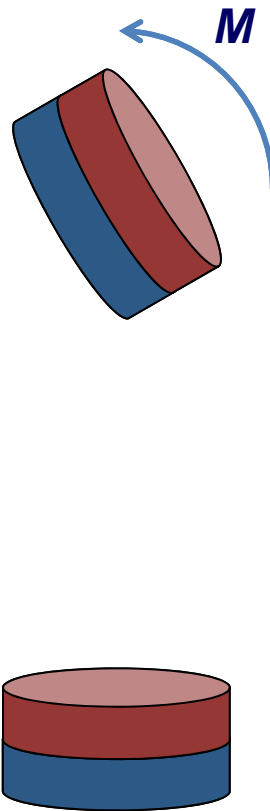
come interagiscono?



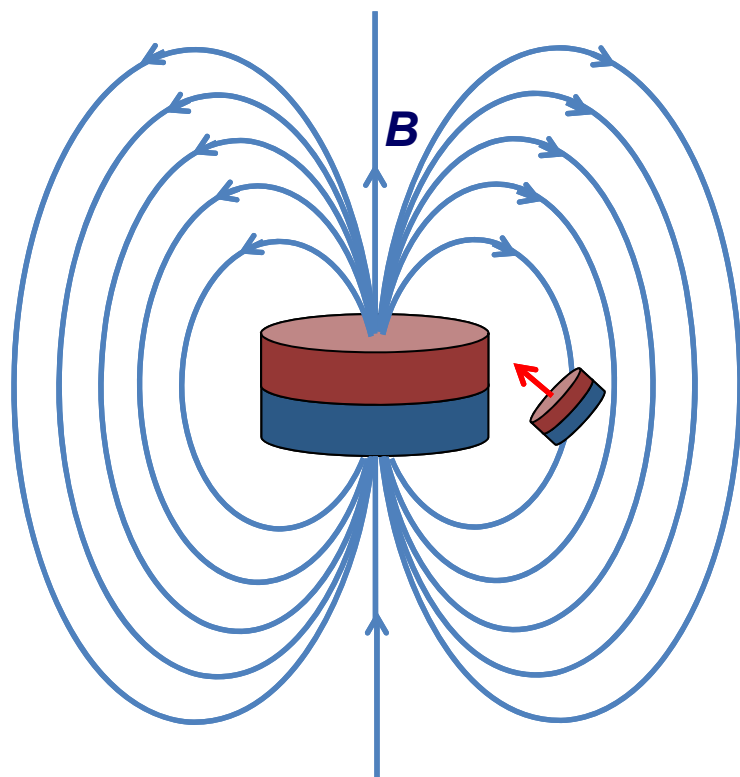
traslazione



rotazione

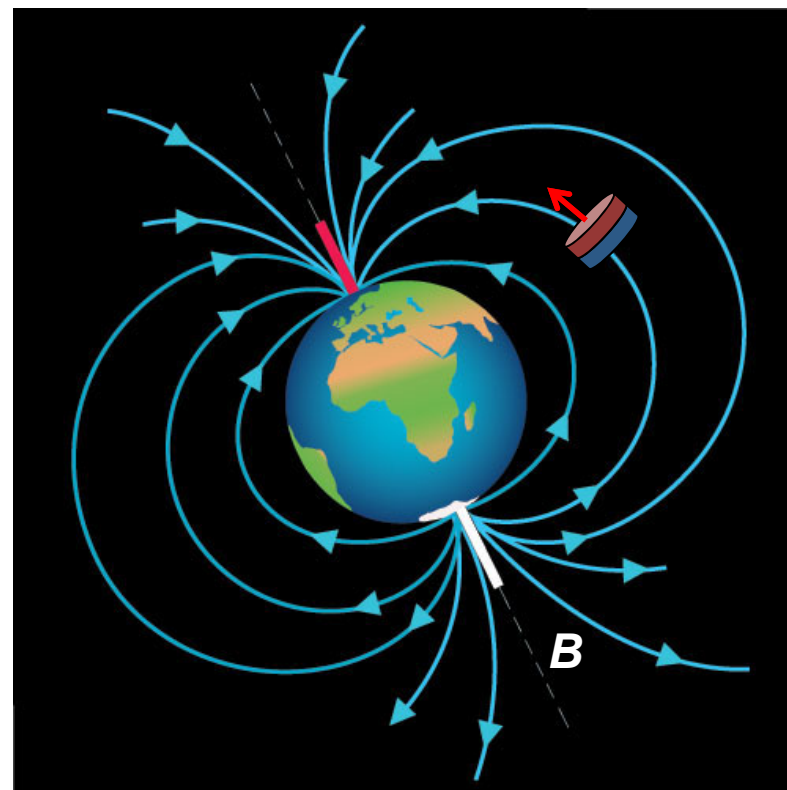


bussola



magnete

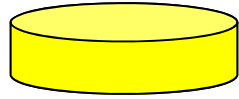
$$B = 0.5 \text{ T}$$



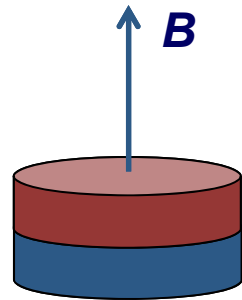
Terra

$$B = 0.5 \text{ G} = 0.00005 \text{ T}$$

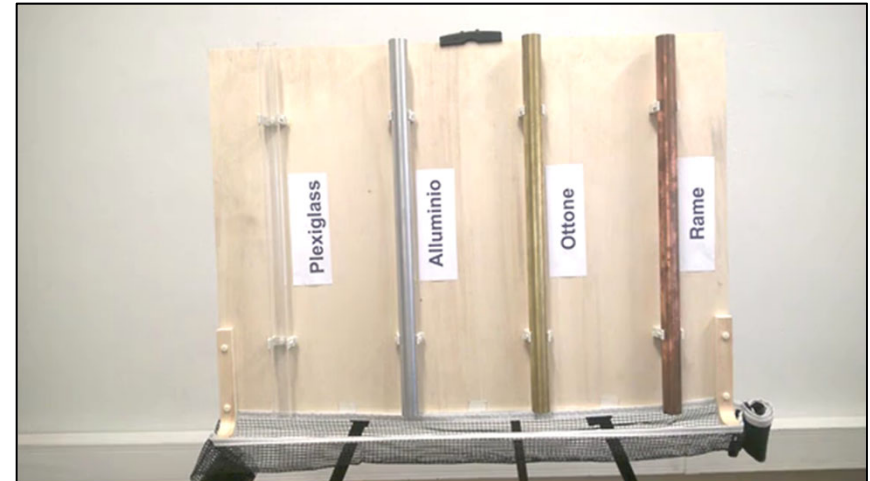
non ferromagnete



magnete



condizioni statiche



condizioni dinamiche

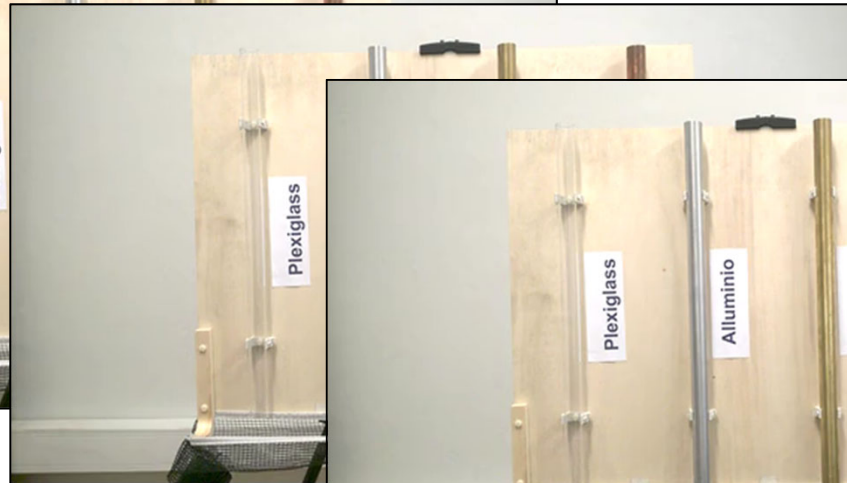
$t = 0.4 \text{ s}$



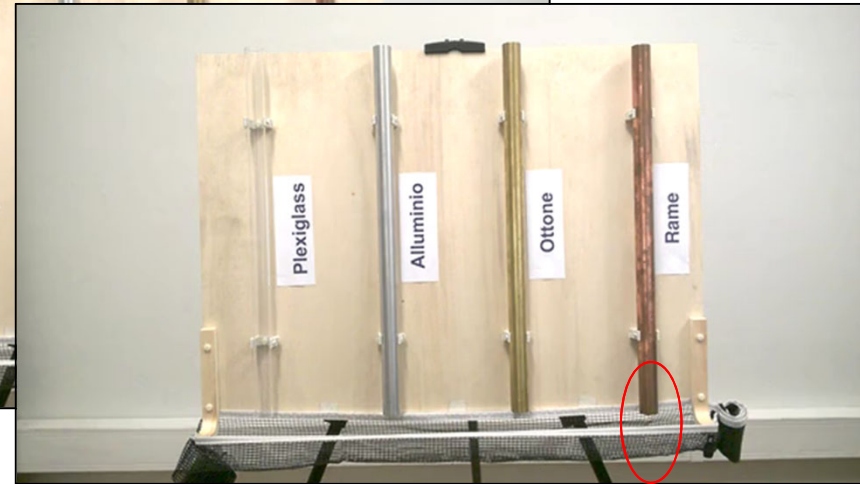
$t = 2.5 \text{ s}$



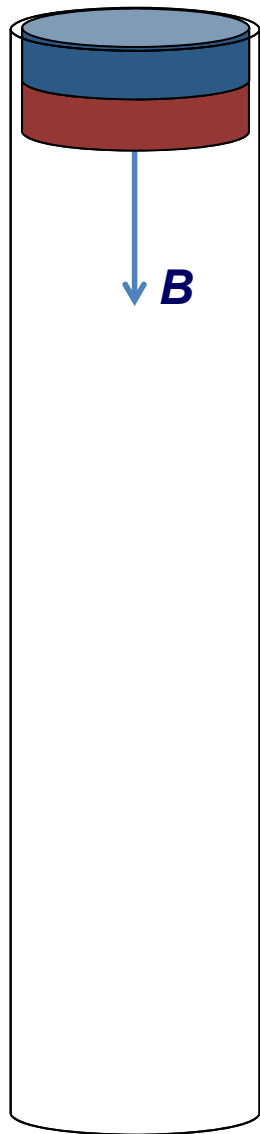
$t = 2.7 \text{ s}$



$t = 5.5 \text{ s}$

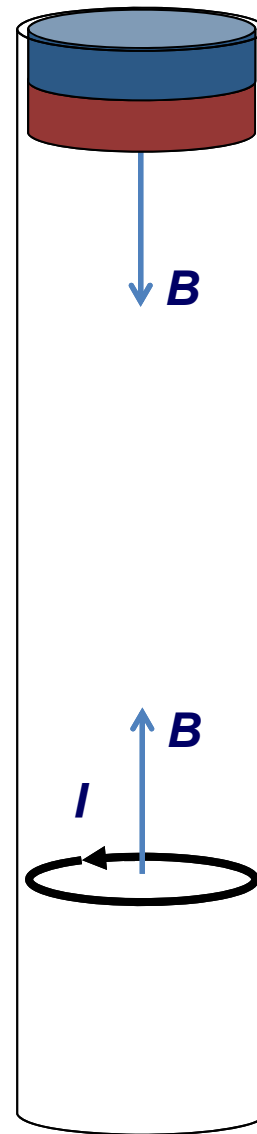
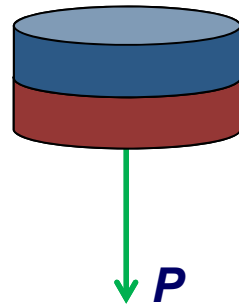


tubo non conduttore



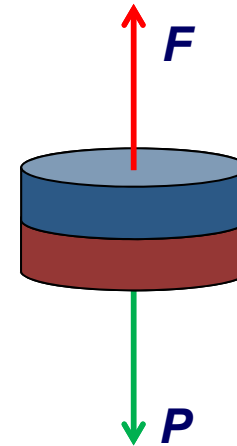
$a = \text{cost}$

tubo conduttore



$v = \text{cost}$

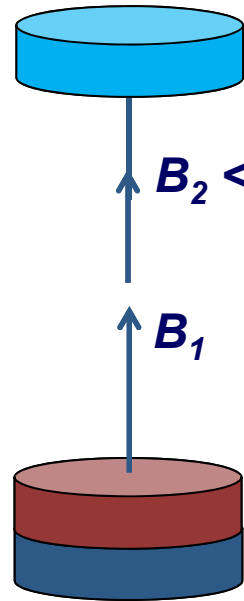
anti-gravità



correnti
di Foucault

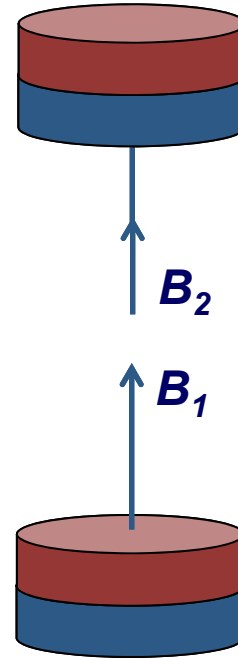
paramagnete

magnete



$B_2 < B_1$

B_1

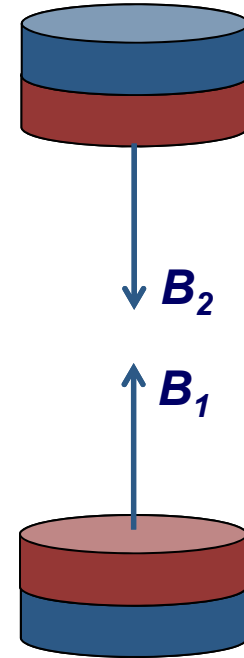


B_2

B_1

F

F



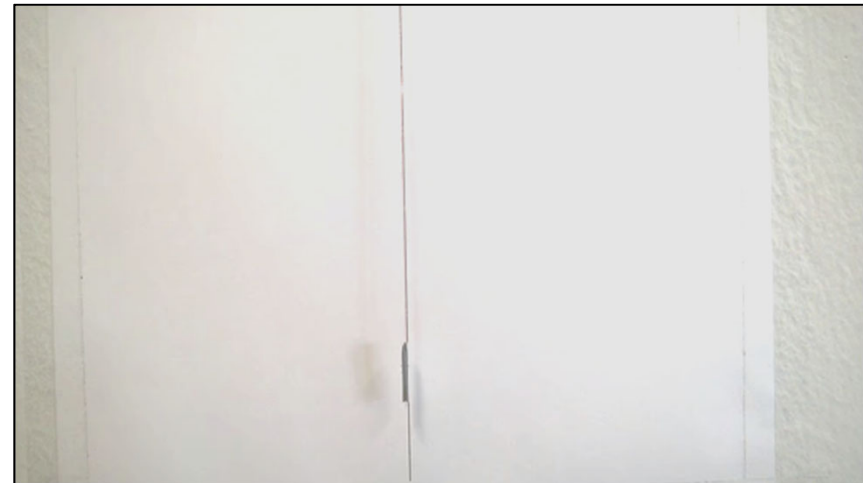
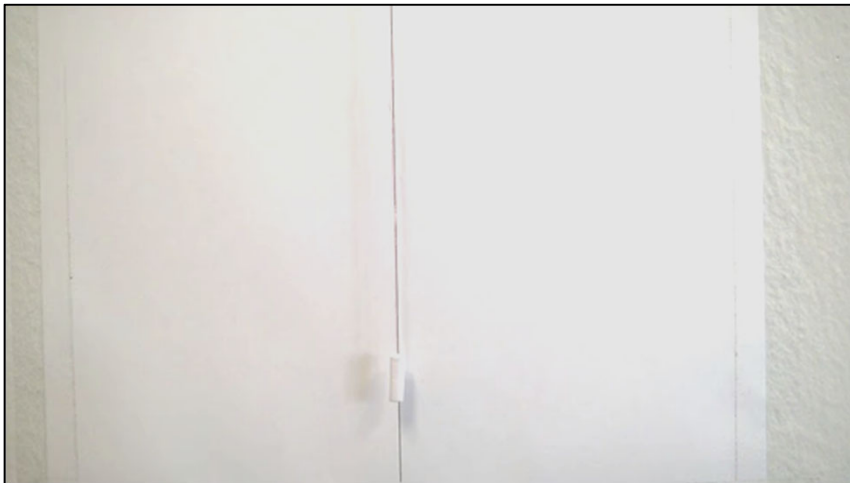
B_2

B_1

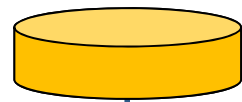
F

F

carta & alluminio

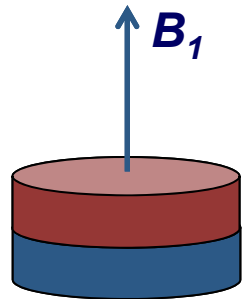


diamagnete

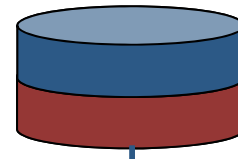


$$\downarrow B_2 < B_1$$

magnete



$$\uparrow B_1$$

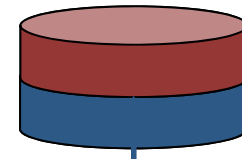


$$\downarrow B_2$$

$$\uparrow B_1$$

F

F



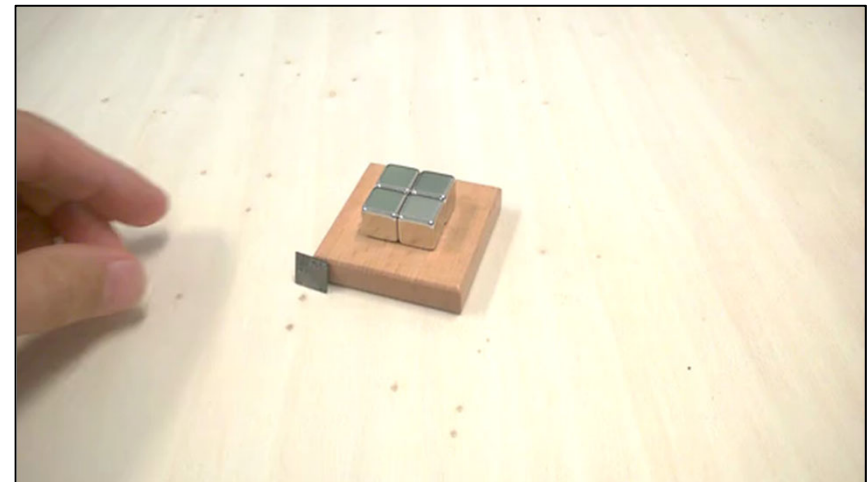
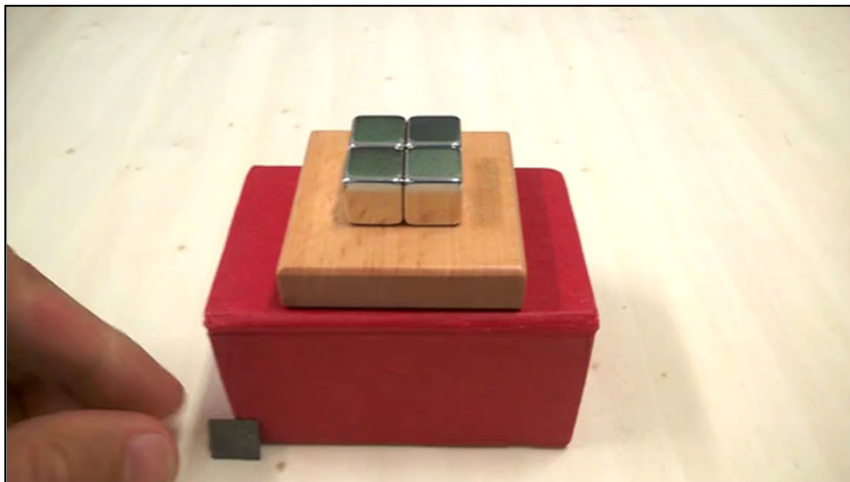
$$\uparrow B_2$$

$$\uparrow B_1$$

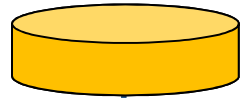
F

F

grafite pirolitica @ 293 K



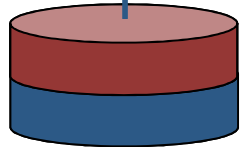
diamagnete perfetto



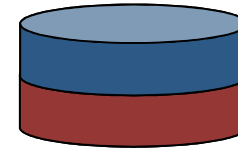
$B_2 = B_1$

B_1

magnete



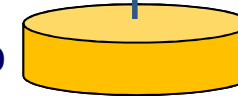
magnete



B_1

$B_2 = B_1$

diamagnete perfetto



YBCO superconduttore @ 70 K



Grazie!

LE GRANDI RACCOLTE PER LA GIOVENTU'



MAGNETO

a cura di Maurizio Zani



LE GRANDI RACCOLTE PER LA GIOVENTU'



ELECTRO

a cura di Maurizio Zani



Nelle migliori edicole...