v2/füüsika ja matemaatikaga seotud mõtted/GM eksperiment/"geometry.cfg"

v2/füüsika ja matemaatikaga seotud mõtted/GM eksperiment/"bblopts.cfg"

v2/füüsika ja matemaatikaga seotud mõtted/GM eksperiment/"english.cfg" v2/füüsika ja matemaatikaga seotud mõtted/GM eksperiment/"gravitomagnetismi_experiment_vana.aux"

GM eksperiment

February 23, 2022

Part I
Sissejuhatus

Eesmärk on kastseliselt demonstreerida GravitiMagneetilist nätust. Gravitimagneetilise välja tekitamiseks kasutataks pöörlevat silndrit.

Part II
sisu

1 G_M välja tekitamine

$B = \frac{dm^2}{dl*dt} * \mu_G$(http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/solenoid.html ja eletromagnetismi ja gravitomagnetismi analoogiale tuginedes)

$\frac{dm^2}{dl*dt} = \int_{r_1}^{r_2}(dr*\rho*v(r)) = \int_{r_1}^{r_2}(dr*\rho*\omega*r) = \rho*\omega*\int_{r_1}^{r_2}(dr*r) = \frac{\rho*\omega*(r_2^2-r_1^2)}{2}$

maksimaalne GMvlja tugevus silindri kohal on $B_G = \frac{\mu_G*\omega*\rho*(r_2^2-r_1^2)}{2} = \mu_G*\omega*\rho*_\Delta l*(R-\frac{\Delta l}{2})$ kus:

- ω nurkkiirus
- μ_G on GM konstant.
- ρ on slindr tihedus.
- r_2
- $_\Delta l$ on slndri paksus.

Et leida maksimaalset nurkkiirust, mis silindril olla saab ilma,et see inertsiaalsete jõudude tõttu puruneks kasutan neid kahte iternetist leitud valemi silindri radiaalse(keskounktist eemale) ja tangensiaalse(joonkiiruse suunalise) pinge leidmiseks. valemid sain(http://www.roymech.co.uk/Useful_Tables/Cams_Springs/Flywheels.html)

$\sigma_{radiaal\ max} = \frac{\rho*\omega*(3+\mu)*(r_2-r_1)^2}{8}$

$\sigma_{tangensiaal\ max} = \frac{\rho*\omega*((1-\mu)*r_1^2+(3+\mu)*r_2^2)}{4}$

- μ on siin aine, millest silidr tehtud on poissoni tegur.

eeldan, et keha ei murdu kui nende ristuvate pingete ruutude summa ei ole keha pingetaluvusese ruudust suurem.

$\sigma_{max} = \sqrt{\sigma_{radiaal\ max}^2 + \sigma_{tangensiaal\ max}^2} = \frac{\omega*\rho*\sqrt{(\mu+3)^2*(r_1-r_2)^4+4*(r_1^2*(\mu-1)-r_2^2*(\mu+3))^2}}{8}$

avaldan siit $\omega = \frac{8*\sigma_{max}}{\rho}\sqrt{-\frac{1}{-5\mu^2r_1^4+4\mu^2r_1^3r_2+2\mu^2r_1^2r_2^2+4\mu^2r_1r_2^3-5\mu^2r_2^4+2\mu r_1^4+24\mu r_1^3r_2-20\mu r_1^2r_2^2+24\mu r_1r_2^3-30\mu r_2^4-13r_1^4+36r_1^3r_2-78r_1^2r_2^2+36r_1r_2^3-45r_2^4}}$

Asendades selle B_G avaldisse saan:

$B_G = \mu_G*\rho*(r_2^2-r_1^2)*\frac{8*\sigma_{max}}{\rho}\sqrt{\frac{1}{5\mu^2r_1^4-4\mu^2r_1^3r_2-2\mu^2r_1^2r_2^2-4\mu^2r_1r_2^3+5\mu^2r_2^4-2\mu r_1^4-24\mu r_1^3r_2+20\mu r_1^2r_2^2-24\mu r_1r_2^3+30\mu r_2^4+13r_1^4-36r_1^3r_2+78r_1^2r_2^2-36r_1r_2^3+45r_2^4}}$

1.1 leian kõige parema paksuse

- ${}_{\Delta}l$ on siliri paksus

${}_{\Delta}l = r_2 - r_1$ seega $r_1 = r_2 -_{\Delta} l$
asendan selle B_G valemisse.
$B_G = \frac{\mu_G * \rho * {}_{\Delta}l * (2*r_2 - {}_{\Delta}l) * 8 * \sigma_{max}}{\rho} \sqrt{\frac{1}{5_{\Delta}l^4\mu^2 - 2_{\Delta}l^4\mu + 13_{\Delta}l^4 - 16_{\Delta}l^3\mu^2 r_2 + 32_{\Delta}l^3\mu r_2 - 16_{\Delta}l^3 r_2 + 16_{\Delta}l^2\mu^2 r_2^2 - 64_{\Delta}l^2\mu r_2^2 + 48_{\Delta}l^2 r_2^2 + 64_{\Delta}l\mu r_2^3 - 64_{\Delta}l r_2^3 + 64 r_2^4}}$
,et leida parim paksus otsin ${}_{\Delta}l$ väärtuse, mille puhul tuletis ${}_{\Delta}l$ kaudu on 0 ja teine tuletis on negatiivne.
$\frac{\partial B_G}{\partial_{\Delta} l} = 0$
$\wedge \frac{\partial^2 B_G}{\partial_{\Delta} l^2} < 0$
ehk
$\frac{\partial(\frac{\mu_G * \rho * {}_{\Delta}l * (2*r_2 - {}_{\Delta}l) * 8 * \sigma_{max}}{\rho} \sqrt{\frac{1}{5_{\Delta}l^4\mu^2 - 2_{\Delta}l^4\mu + 13_{\Delta}l^4 - 16_{\Delta}l^3\mu^2 r_2 + 32_{\Delta}l^3\mu r_2 - 16_{\Delta}l^3 r_2 + 16_{\Delta}l^2\mu^2 r_2^2 - 64_{\Delta}l^2\mu r_2^2 + 48_{\Delta}l^2 r_2^2 + 64_{\Delta}l\mu r_2^3 - 64_{\Delta}l r_2^3 + 64 r_2^4}})}{\partial_{\Delta} l} = 0$
$\wedge \frac{\partial^2(\frac{\mu_G * \rho * {}_{\Delta}l * (2*r_2 - {}_{\Delta}l) * 8 * \sigma_{max}}{\rho} \sqrt{\frac{1}{5_{\Delta}l^4\mu^2 - 2_{\Delta}l^4\mu + 13_{\Delta}l^4 - 16_{\Delta}l^3\mu^2 r_2 + 32_{\Delta}l^3\mu r_2 - 16_{\Delta}l^3 r_2 + 16_{\Delta}l^2\mu^2 r_2^2 - 64_{\Delta}l^2\mu r_2^2 + 48_{\Delta}l^2 r_2^2 + 64_{\Delta}l\mu r_2^3 - 64_{\Delta}l r_2^3 + 64 r_2^4}})}{\partial_{\Delta} l^2} < 0$
ehk
$\frac{r_2\sigma(-16dl^4\mu^2 - 96dl^4\mu - 144dl^4 + 256dl^3\mu r_2 - 256dl^3 r_2 - 768dl^2\mu r_2^2 + 768dl^2 r_2^2 + 512dl\mu r_2^3 - 1536dl r_2^3 + 1024 r_2^4)\sqrt{\frac{1}{5dl^4\mu^2 - 2dl^4\mu + 13dl^4 - 16dl^3\mu^2 r_2 + 32dl^3\mu r_2 - 16dl^3 r_2 + 16dl^2\mu^2 r_2^2 - 64dl^2\mu r_2^2 + 48dl^2 r_2^2 + 64dl\mu r_2^3 - 64dl r_2^3 + 64 r_2^4}}}{5dl^4\mu^2 - 2dl^4\mu + 13dl^4 - 16dl^3\mu^2 r_2 + 32dl^3\mu r_2 - 16dl^3 r_2 + 16dl^2\mu^2 r_2^2 - 64dl^2\mu r_2^2 + 48dl^2 r_2^2 + 64dl\mu r_2^3 - 64dl r_2^3 + 64 r_2^4} = 0$
$\wedge \frac{\partial^2 B_G}{\partial_{\Delta} l^2} < 0$
ehk
$-16dl^4\mu^2 - 96dl^4\mu - 144dl^4 + 256dl^3\mu r_2 - 256dl^3 r_2 - 768dl^2\mu r_2^2 + 768dl^2 r_2^2 + 512dl\mu r_2^3 - 1536dl r_2^3 + 1024 r_2^4 = 0$
$\wedge \frac{\partial^2 B_G}{\partial_{\Delta} l^2} < 0$

Parimal juhul kui:

- $\sigma \approx -2$
- $\rho \approx 22570$
- $\sigma \approx 3.3 * 10^{-10}$
- $r_1 \approx -2$
- $r_2 \approx -2$

Siis $B_G \approx 5,56488343912850 * 10^{-16} * s^{-1}$

Part III
Sisu 2

2 G_M välja tekitamine

$B = \frac{dm^2}{dl*dt} * \mu_G$(http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/solenoid.html ja eletromagnetismi ja gravitomagnetismi analoogiale tuginedes)
$\frac{dm^2}{dl*dt} = \int_{r_1}^{r_2}(dr * \rho * v(r)) = \int_{r_1}^{r_2}(dr * \rho * \omega * r) = \rho * \omega * \int_{r_1}^{r_2}(dr * r) = \frac{\rho*\omega*(r_2^2 - r_1^2)}{2}$
maksimaalne GMvlja tugevus silindri kohal on $B_G = \frac{\mu_G*\omega*\rho*(r_2^2 - r_1^2)}{2}$ kus:

- ω nurkkiirus
- μ_G on GM konstant.
- ρ on slindr tihedus.

- r_2

Et leida maksimaalset nurkkiirust, mis silindril olla saab ilma,et see inertsiaalsete jõudude tõttu puruneks kasutan neid kahte iternetist leitud valemi silindri radiaalse(keskounktist eemale) ja tangensiaalse(joonkiiruse suunalise) pinge leidmiseks. valemid sain(http://www.roymech.co.uk/Useful_Tables/Cams_Springs/Flywheels.html)

$\sigma_{radiaal\ max} = \frac{\rho*\omega*(3+\mu)*(r_2-r_1)^2}{8}$
$\sigma_{tangensiaal\ max} = \frac{\rho*\omega*((1-\mu)*r_1^2+(3+\mu)*r_2^2)}{4}$

- μ on siin aine, millest silidr tehtud on poissoni tegur.

eeldan, et keha ei murdu kui nende ristuvate pingete ruutude summa ei ole keha pingetaluvusese ruudust suurem.

$\sigma_{max} = \sqrt{\sigma_{radiaal\ max}^2 + \sigma_{tangensiaal\ max}^2} = \frac{\omega*\rho*\sqrt{(\mu+3)^2*(r_1-r_2)^4+4*(r_1^2*(\mu-1)-r_2^2*(\mu+3))^2}}{8}$
avaldan siit $\omega = \frac{8*\sigma_{max}}{\rho}\sqrt{-\frac{1}{-5\mu^2 r_1^4+4\mu^2 r_1^3 r_2+2\mu^2 r_1^2 r_2^2+4\mu^2 r_1 r_2^3-5\mu^2 r_2^4+2\mu r_1^4+24\mu r_1^3 r_2-20\mu r_1^2 r_2^2+24\mu r_1 r_2^3-30\mu r_2^4-13r_1^4+36r_1^3 r_2-78r_1^2 r_2^2+36r_1 r_2^3-45r_2^4}}$
Asendades selle B_G avaldisse saan:
$B_G = \mu_G*\rho*(r_2^2-r_1^2)*\frac{8*\sigma_{max}}{\rho}\sqrt{\frac{1}{5\mu^2 r_1^4-4\mu^2 r_1^3 r_2-2\mu^2 r_1^2 r_2^2-4\mu^2 r_1 r_2^3+5\mu^2 r_2^4-2\mu r_1^4-24\mu r_1^3 r_2+20\mu r_1^2 r_2^2-24\mu r_1 r_2^3+30\mu r_2^4+13r_1^4-36r_1^3 r_2+78r_1^2 r_2^2-36r_1 r_2^3+45r_2^4}}$

2.1 leian kõige parema täidetuse

- p on,et kui suure osa kogu raadiusest on täitmata osa raadiud

$p = r_1/r_2$ seega $r_1 = p*r_2$.
asendan selle B_G valemisse.
$B_G = 4v_g\sigma\sqrt{-\frac{1}{-5\mu^2 p^4+4\mu^2 p^3+2\mu^2 p^2+4\mu^2 p-5\mu^2+2\mu p^4+24\mu p^3-20\mu p^2+24\mu p-30\mu-13p^4+36p^3-78p^2+36p-45}}*(1-p^2)$
,et leida parim täidetus otsin p väärtuse, mille puhul tuletis p kaudu on 0 ja teine tuletis on negatiivne.
$\frac{\partial B_G}{\partial p} = 0$
$\wedge \frac{\partial^2 B_G}{\partial p^2} < 0$
ehk
$\frac{\partial(\frac{\mu_G*\rho*{}_\Delta l*(2*r_2-{}_\Delta l)*8*\sigma_{max}}{\rho}\sqrt{\frac{1}{5{}_\Delta l^4\mu^2-2{}_\Delta l^4\mu+13{}_\Delta l^4-16{}_\Delta l^3\mu^2 r_2+32{}_\Delta l^3\mu r_2-16{}_\Delta l^3 r_2+16{}_\Delta l^2\mu^2 r_2^2-64{}_\Delta l^2\mu r_2^2+48{}_\Delta l^2 r_2^2+64{}_\Delta l\mu r_2^3-64{}_\Delta l r_2^3+64r_2^4}})}{\partial_\Delta l} = 0$
$\wedge \frac{\partial^2(\frac{\mu_G*\rho*{}_\Delta l*(2*r_2-{}_\Delta l)*8*\sigma_{max}}{\rho}\sqrt{\frac{1}{5{}_\Delta l^4\mu^2-2{}_\Delta l^4\mu+13{}_\Delta l^4-16{}_\Delta l^3\mu^2 r_2+32{}_\Delta l^3\mu r_2-16{}_\Delta l^3 r_2+16{}_\Delta l^2\mu^2 r_2^2-64{}_\Delta l^2\mu r_2^2+48{}_\Delta l^2 r_2^2+64{}_\Delta l\mu r_2^3-64{}_\Delta l r_2^3+64r_2^4}})}{\partial_\Delta l^2} < 0$
ehk
$\frac{v_g\sigma\sqrt{-\frac{1}{-5\mu^2 p^4+4\mu^2 p^3+2\mu^2 p^2+4\mu^2 p-5\mu^2+2\mu p^4+24\mu p^3-20\mu p^2+24\mu p-30\mu-13p^4+36p^3-78p^2+36p-45}}}{5\mu^2 p^4-4\mu^2 p^3-2\mu^2 p^2-4\mu^2 p+5\mu^2-2\mu p^4-24\mu p^3+20\mu p^2-24\mu p+30\mu+13p^4-36p^3+78p^2-36p+45}\left(8\mu^2 p^4-32\mu^2 p^3+48\mu^2 p^2-32\mu^2 p+8\mu^2+48\mu p^4-64\mu p^3+288\mu p^2-320\mu p+48\mu+72p^4-416p^3+432p^2-672p+72\right) =$
0
$\wedge \frac{\partial^2 B_G}{\partial_\Delta l^2} < 0$
ehk
$8\mu^2 p^4-32\mu^2 p^3+48\mu^2 p^2-32\mu^2 p+8\mu^2+48\mu p^4-64\mu p^3+288\mu p^2-320\mu p+48\mu+72p^4-416p^3+432p^2-672p+72 = 0$
$\wedge \frac{\partial^2 B_G}{\partial_\Delta l^2} < 0$
###
lasilk asendus:$r_1 = p*r_2$. lihtsam parim p leida kui parim _Delta l leida
$\frac{1v_g\sigma\sqrt{-\frac{1}{-5\mu^2 p^4+4\mu^2 p^3+2\mu^2 p^2+4\mu^2 p-5\mu^2+2\mu p^4+24\mu p^3-20\mu p^2+24\mu p-30\mu-13p^4+36p^3-78p^2+36p-45}}}{5\mu^2 p^4-4\mu^2 p^3-2\mu^2 p^2-4\mu^2 p+5\mu^2-2\mu p^4-24\mu p^3+20\mu p^2-24\mu p+30\mu+13p^4-36p^3+78p^2-36p+45}\left(8\mu^2 p^4-32\mu^2 p^3+48\mu^2 p^2-32\mu^2 p+8\mu^2+48\mu p^4-64\mu p^3+288\mu p^2-320\mu p+48\mu+72p^4-416p^3+432p^2-672p+72\right)$

3 GM välja detekteerimise meetodid

3.1 neutronite kõrvalekaldumine

$F = 4*B\times v$

3.2 keerleva ketta keeramine

Sekundaarse ketta pöörlemistelg on primaarse silindriga 90 kraadi kaldus. $F = 4*\frac{\partial m}{t}*B_G*l_juhe =$

3.3 teise suure inertsiomomendiga silndrile jõumomendi tekitamine.

$\tau = \int (dr * (2\pi * r) * h * \rho_2 * E_G * r * 4) = -\int (dr * (2\pi * r) * h * \rho_2 * \frac{r * \frac{\partial B_G}{\partial t}}{2} * r * 4) = -\frac{2\pi * h * \rho_2 * \frac{\partial B_G}{\partial t} * (r_{2.2}^4 - r_{2.1}^4)}{2} = -\frac{2\pi * h * \rho_2 * B_G * (r_{2.2}^4 - r_{2.1}^4)}{2 *_\Delta t}$

3.4 teise silndri pöörlema panemine

- roo_2 on teise silindri tihedus
- r_2.1 on teise õõnes silindri välimine raadius.
- r_2.2 on teise õõnes silindri sisemine raadius.
- E_G on gravitatsiooni väli.
- E_G on gravitimagneetilineväli.
- tau on jõumoment.
- I on inertsimoment.

GEM võrrand: $rot(E_G) = -\frac{\partial B_G}{\partial t}$

$2 * \pi * r * E_G = -\pi * r^2 * \frac{\partial B_G}{\partial t}$

$E_G = -\frac{r * \frac{\partial B_G}{\partial t}}{2}$

$\tau = \int (dr * (2\pi * r) * h * \rho_2 * E_G * r * 4) = -\int (dr * (2\pi * r) * h * \rho_2 * \frac{r * \frac{\partial B_G}{\partial t} * 4}{2} * r) = -\frac{2\pi * h * \rho_2 * \frac{\partial B_G}{\partial t} * (r_{2.2}^4 - r_{2.1}^4)}{2}$

$I = \frac{m * (r_{2.2}^2 - r_{2.1}^2)}{2} = \frac{\pi * h * \rho_2 * (r_{2.2}^2 - r_{2.1}^2)^2}{2}$

$\omega = \int (\frac{\tau * dt}{I}) = \int (\frac{2\pi * h * \rho_2 * \frac{\partial B_G}{\partial t} * (r_{2.2}^4 - r_{2.1}^4) * dt}{4 * \pi * h * \rho_2 * (r_{2.2}^2 - r_{2.1}^2)^2}) = \int (\frac{\frac{\partial B_G}{\partial t} * (r_{2.2}^4 - r_{2.1}^4) * dt}{2 * (r_{2.2}^2 - r_{2.1}^2)^2}) = \frac{\Delta B_G * (r_{2.2}^4 - r_{2.1}^4)}{2 * (r_{2.2}^2 - r_{2.1}^2)^2}$