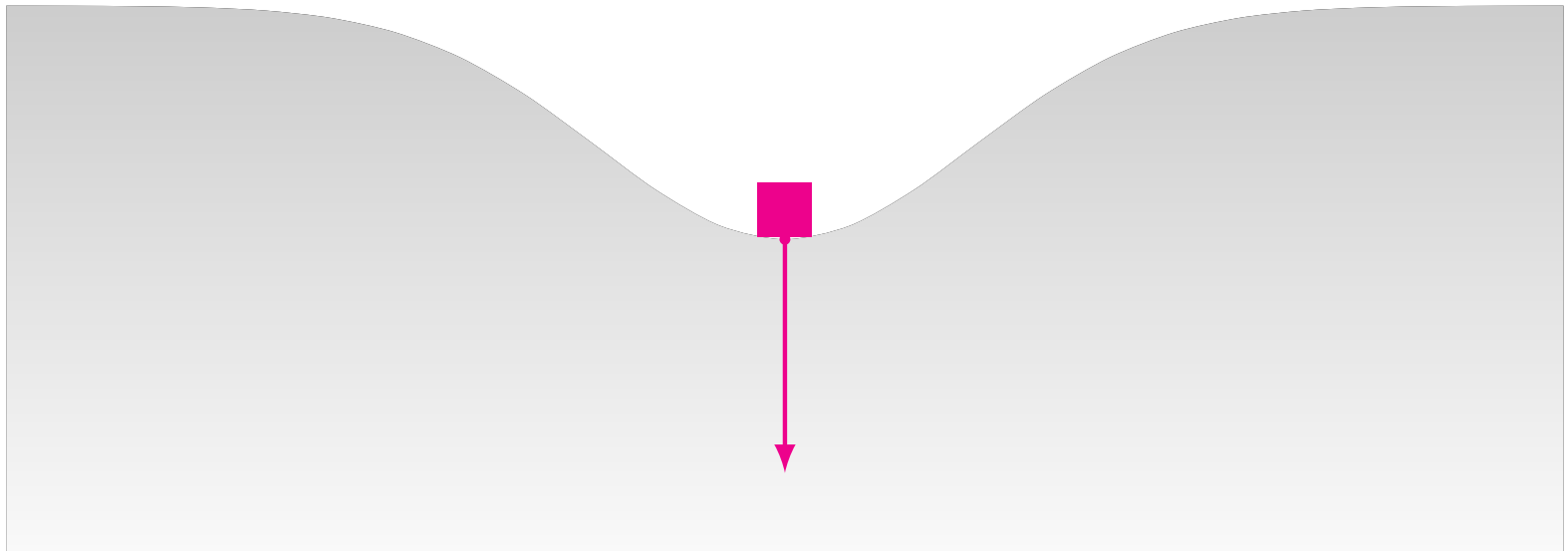
Fale pływowe

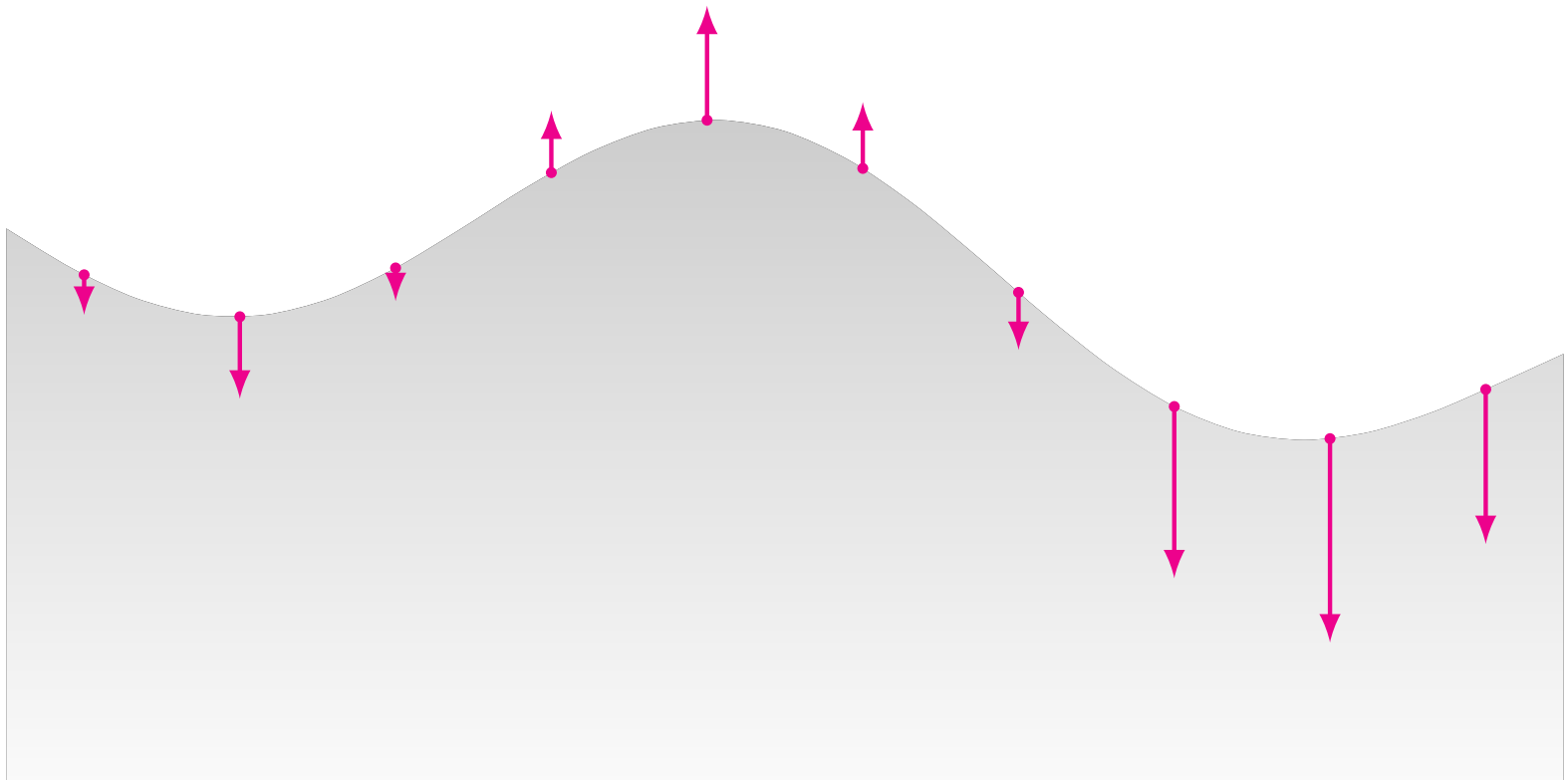
Ćwiczenie: Deformacje obciążeniowe
[geodynmika zaoczni]

wersja z 24 listopada 2014

Skorupa jest elastyczna!



Skorupa jest elastyczna!



Ćwiczenie

a) Obliczyć deformacje Ziemi (składowe h, n, e) w punkcie o zadanych współrzędnych $\varphi = 52°0'0''$ i $\lambda = 21°0'0''$.

Armia niemiecka	Armia Czerwona		kg
900 000	1 336 000	żołnierzy	80
10 000	19 100	moździerzy	200
2700	3444	czołgów	30 000
2500	2900	samolotów	10 000
		$\sum$	370 100 000
		$\times$	1000
		$\sum \times$	370 100 000 000

$\psi\,[^\circ]$	G_r	G_h
0.0001	−33.640	−11.250
0.001	−33.560	−11.250
0.01	−32.750	−11.240
0.02	−31.860	−11.210
0.03	−30.980	−11.160
0.04	−30.120	−11.090
0.06	−28.440	−10.900
0.08	−26.870	−10.650
0.1	−25.410	−10.360
0.16	−21.800	−9.368
0.2	−20.020	−8.723
0.25	−18.360	−8.024
0.3	−17.180	−7.467
0.4	−15.710	−6.725
0.5	−14.910	−6.333
0.6	−14.410	−6.150
0.8	−13.690	−6.050
1	−13.010	−5.997

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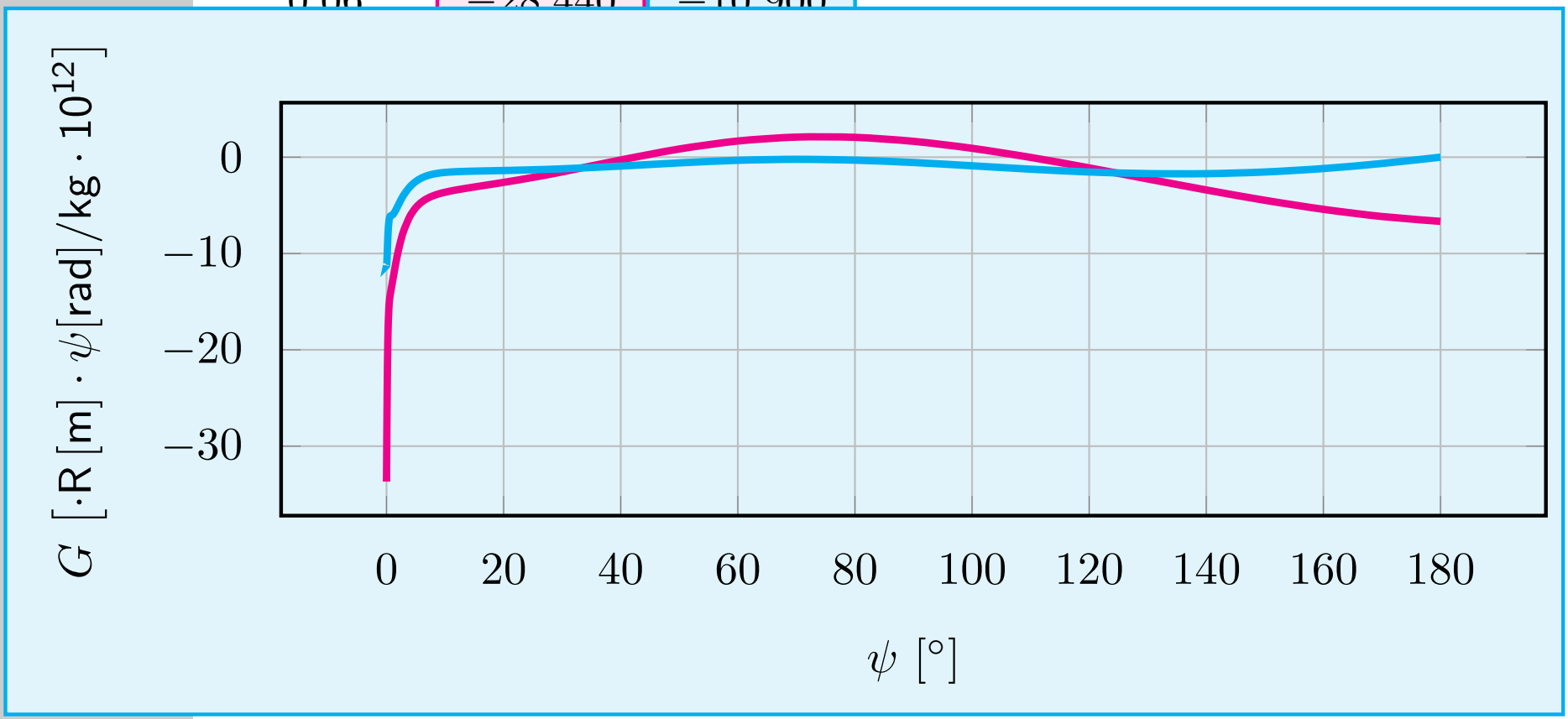

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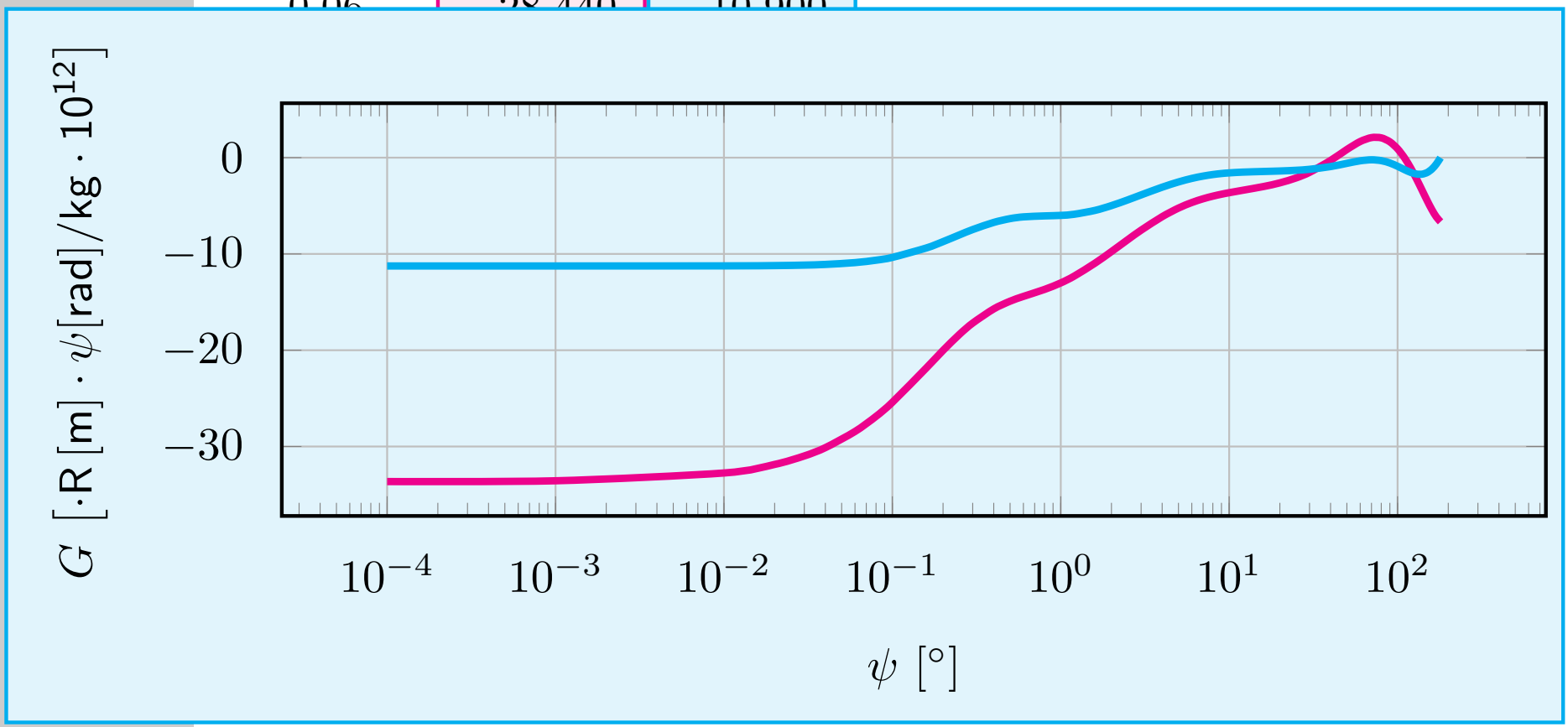

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$$G_r = \frac{a}{m} \cdot \sum_{1}^{\infty} h'_n \cdot P_n(\cos\psi)$$

$$G_h = \frac{a}{m} \cdot \sum_{1}^{\infty} l'_n \cdot \frac{\partial P_n(\cos\psi)}{\partial\psi} \cdot (-\cos\alpha, -\sin\alpha)$$

$\psi\,[^\circ]$	G_r	G_h
1.2	−12.310	−5.881
1.6	−10.950	−5.475
2	−9.757	−4.981
2.5	−8.519	−4.388
3	−7.533	−3.868
4	−6.131	−3.068
5	−5.237	−2.523
6	−4.660	−2.156
7	−4.272	−1.915
8	−3.999	−1.754
9	−3.798	−1.649
10	−3.640	−1.582
12	−3.392	−1.504
16	−2.999	−1.435
20	−2.619	−1.386
25	−2.103	−1.312
30	−1.530	−1.211
40	−0.292	−0.926

$\psi\,[^\circ]$	G_r	G_h
50	0.848	−0.592
60	1.676	−0.326
70	2.083	−0.223
80	2.057	−0.310
90	1.643	−0.555
100	0.920	−0.894
110	−0.025	−1.247
120	−1.112	−1.537
130	−2.261	−1.706
140	−3.405	−1.713
150	−4.476	−1.540
160	−5.414	−1.182
170	−6.161	−0.657
180	−6.663	0.000

Przykład

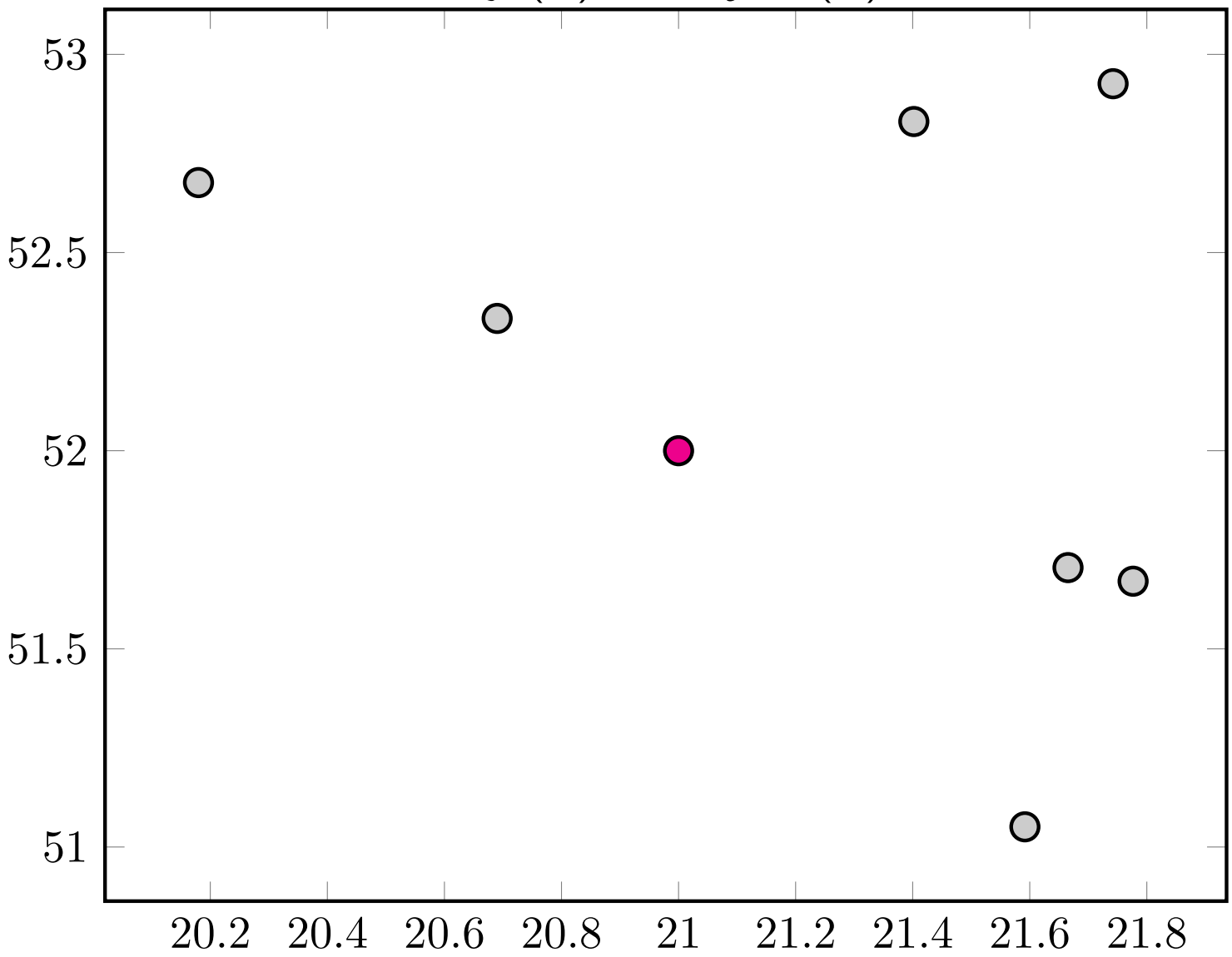
- Dane do zadania

Wykaz 1: Dane do zadania

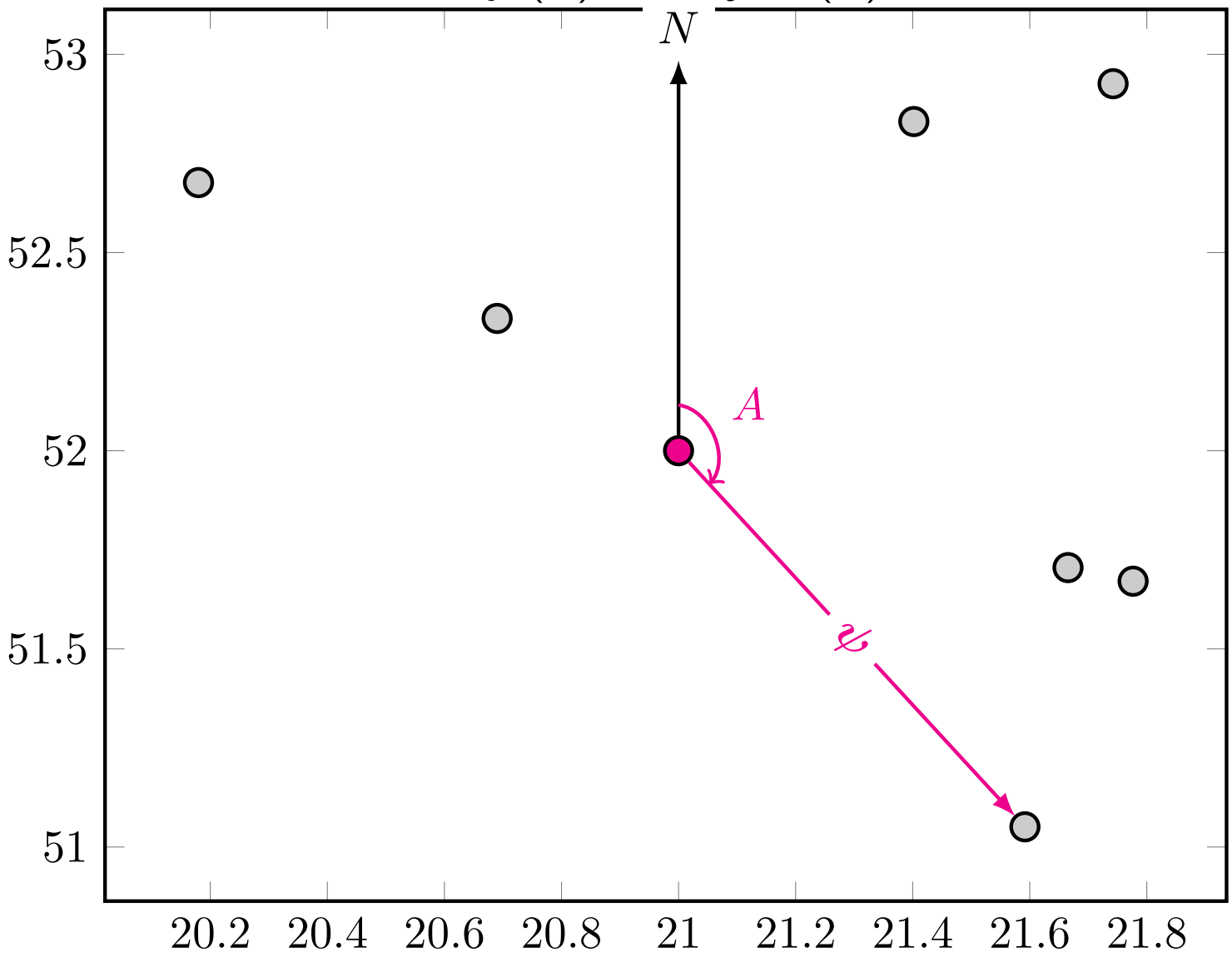
```
#-------------------------------------------------------------------------
# nr     fi [st dz]     la [st dz]                 masa [kg]
#-------------------------------------------------------------------------
   0       51.05096       21.59173            122699927392.4
   0       51.70503       21.66539             50141476421.7
   0       52.33383       20.69009              8304866387.0
   0       52.92611       21.74237            151704279735.2
   0       52.67658       20.17984             16312927202.9
   0       51.67071       21.77657              6733961634.0
   0       52.83065       21.40196             14202572234.7
#-------------------------------------------------------------------------
```

(indywidualne dane do zadania na końcu prezentacji)

- Rozmieszczenie stacji (●) i obciążeń (○).

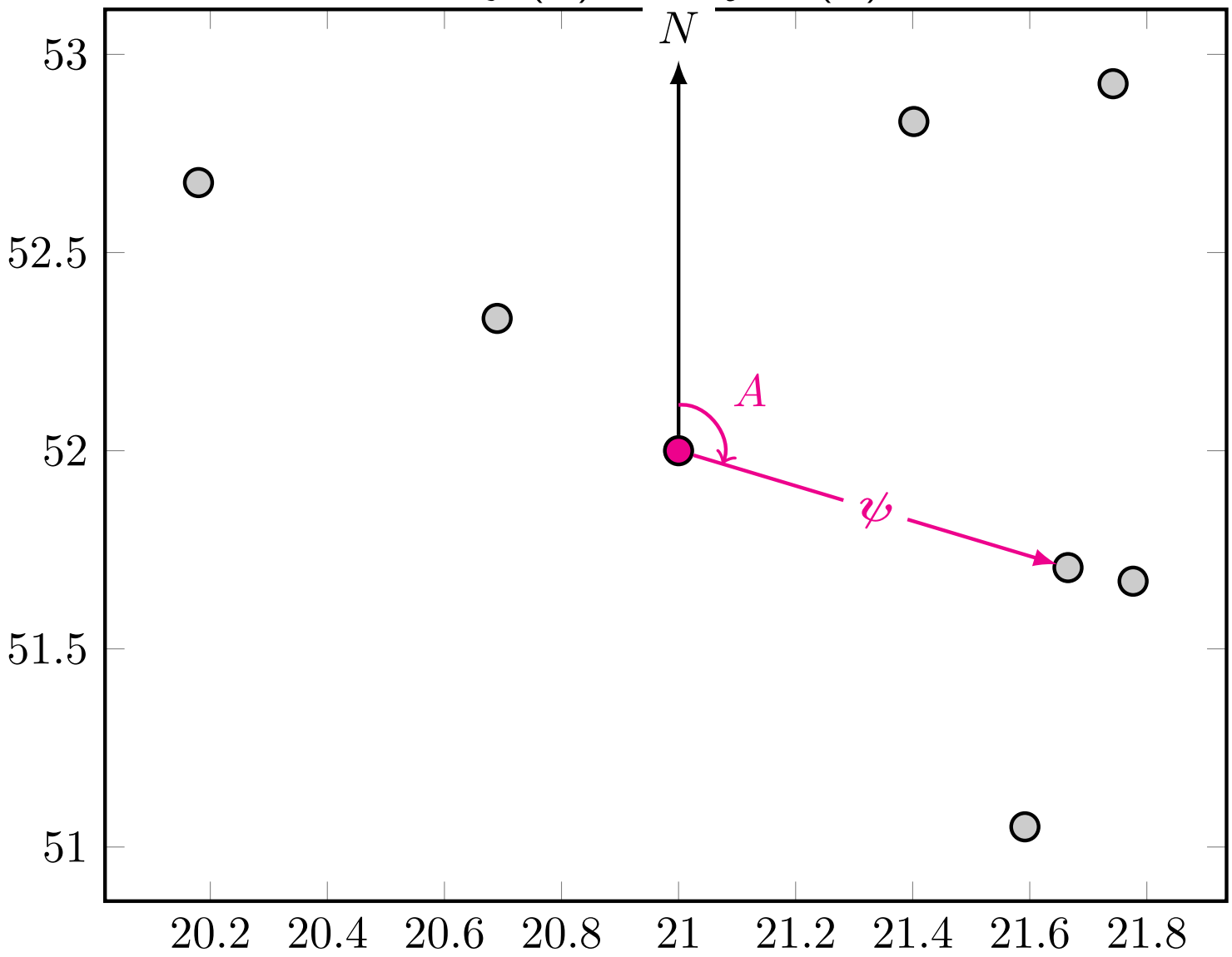


- Rozmieszczenie stacji (●) i obciążeń (○).

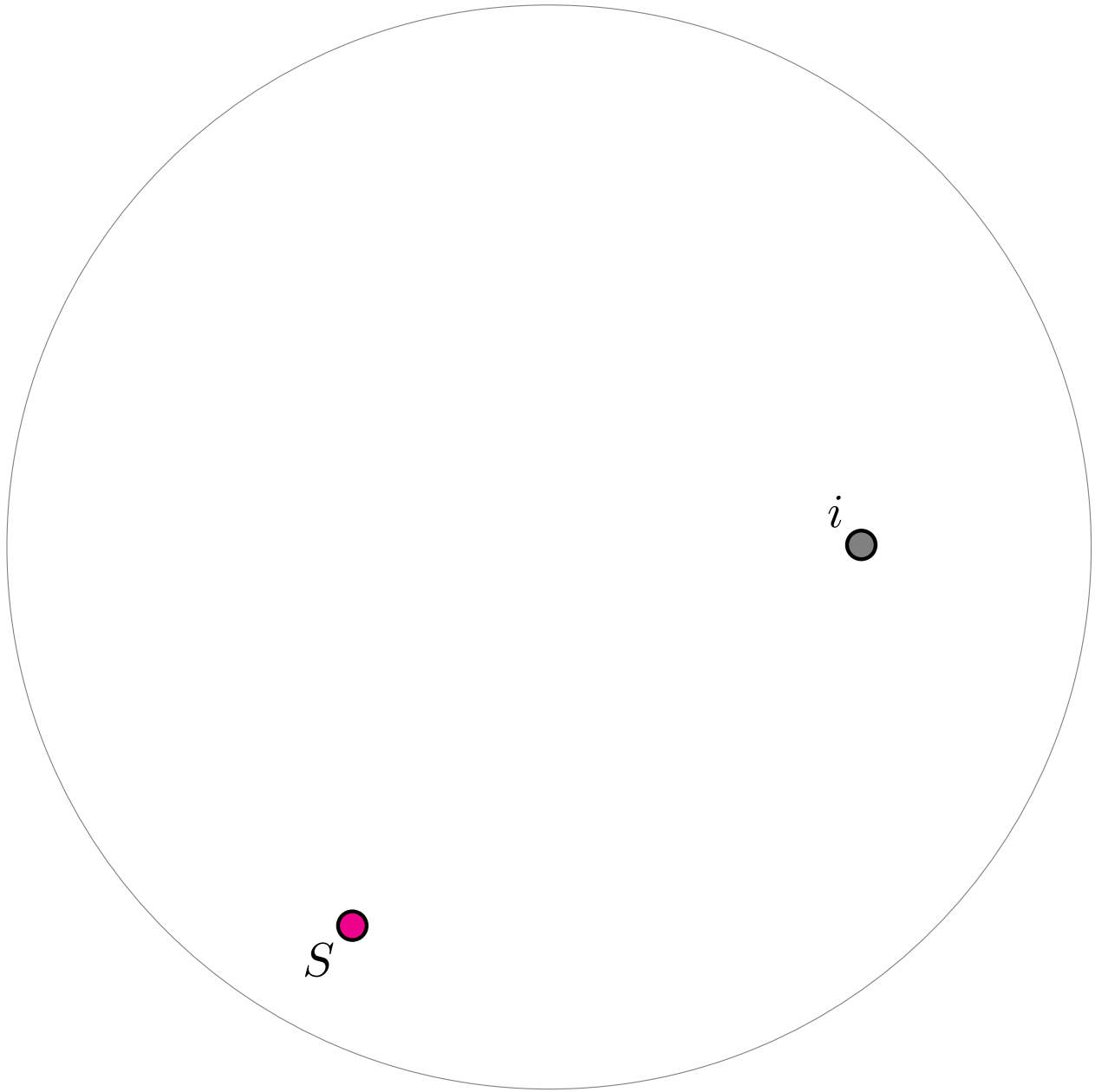


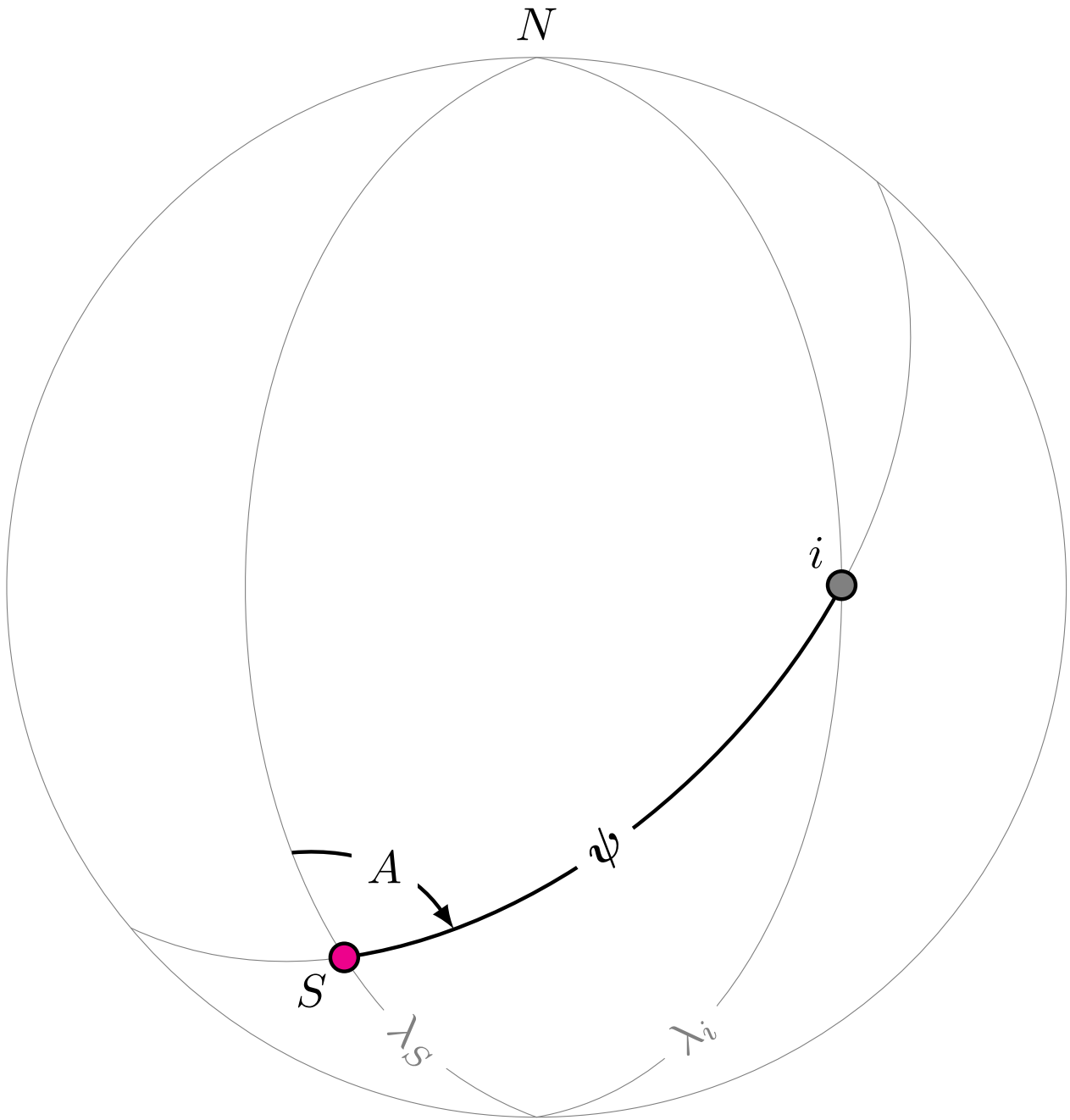
Z wzorów trygonometrii sferycznej

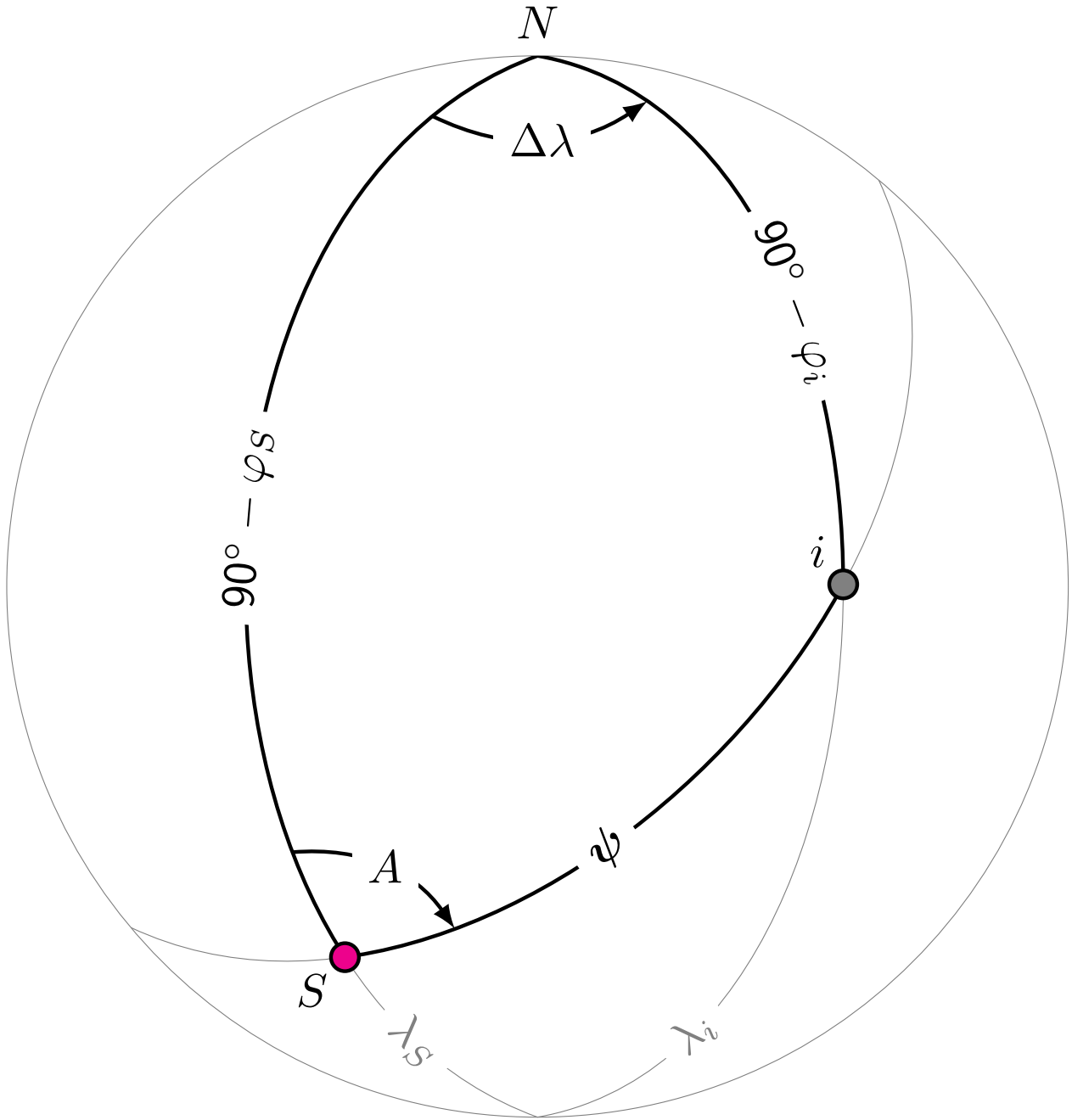
- Rozmieszczenie stacji (●) i obciążeń (○).

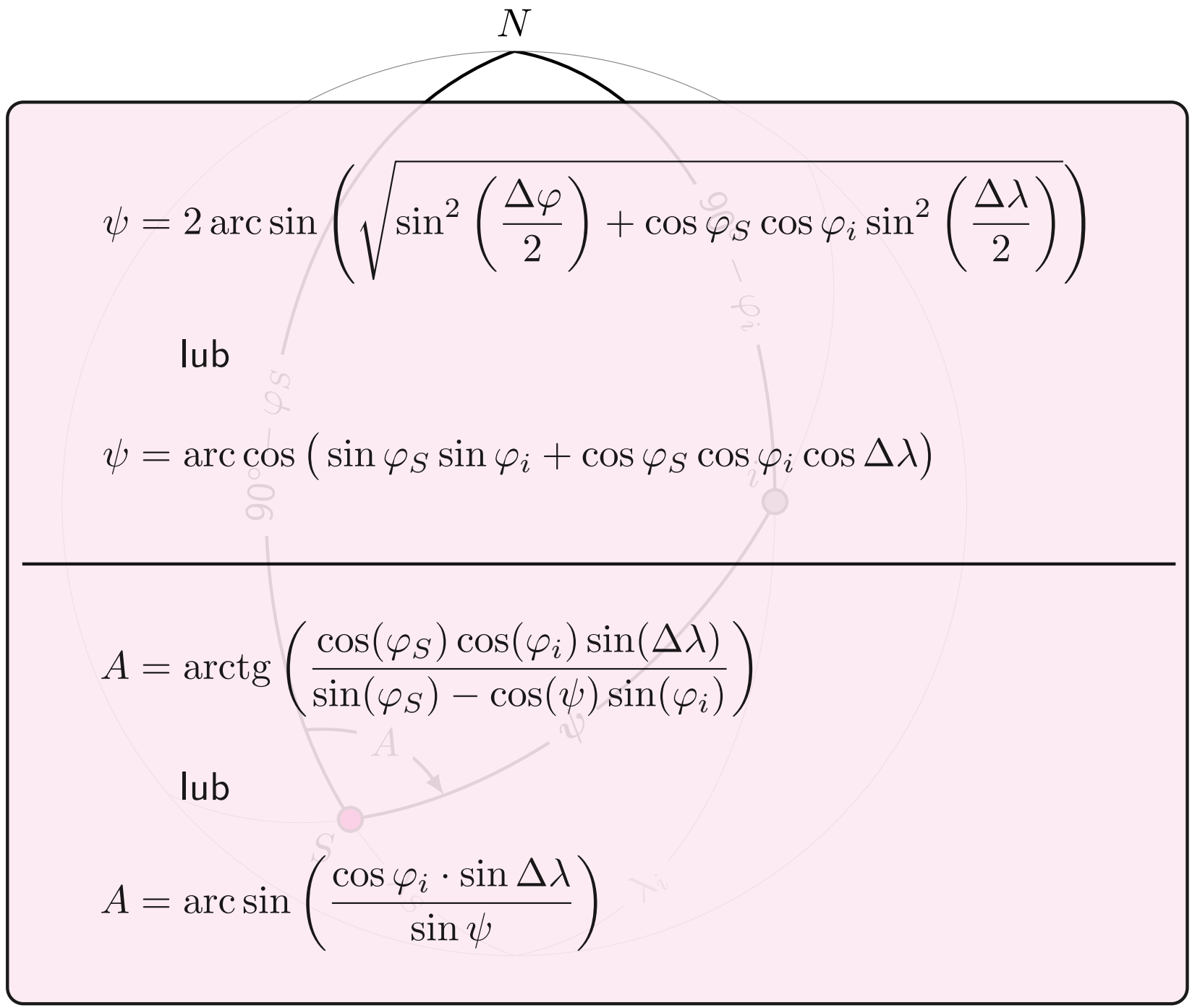


Z wzorów trygonometrii sferycznej


i
S


N
i
A
ψ
S
λS
λi


N
Δλ
90° − φi
90° − φs
i
A
ψ
S
λs
λi



$$\psi = 2 \operatorname{arc\,sin}\left(\sqrt{\sin^2\left(\frac{\Delta\varphi}{2}\right) + \cos\varphi_S \cos\varphi_i \sin^2\left(\frac{\Delta\lambda}{2}\right)}\right)$$

lub

$$\psi = \operatorname{arc\,cos}\left(\sin\varphi_S \sin\varphi_i + \cos\varphi_S \cos\varphi_i \cos\Delta\lambda\right)$$

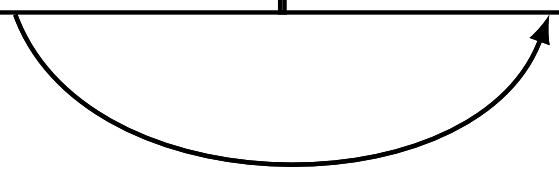
$$A = \operatorname{arctg}\left(\frac{\cos(\varphi_S)\cos(\varphi_i)\sin(\Delta\lambda)}{\sin(\varphi_S) - \cos(\psi)\sin(\varphi_i)}\right)$$

lub

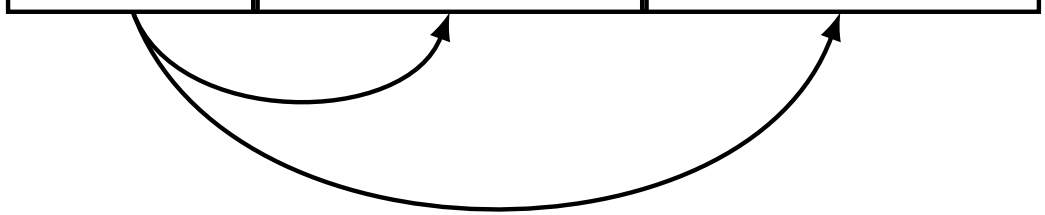
$$A = \operatorname{arc\,sin}\left(\frac{\cos\varphi_i \cdot \sin\Delta\lambda}{\sin\psi}\right)$$

$\varphi\,[^\circ]$	$\lambda\,[^\circ]$
$51,05096$	$21,59173$
$51,70503$	$21,66539$
$52,33383$	$20,69009$
$52,92611$	$21,74237$
$52,67658$	$20,17984$
$51,67071$	$21,77657$
$52,83065$	$21,40196$

$\varphi\,[^\circ]$	$\lambda\,[^\circ]$	$\psi\,[^\circ]$	$A\,[^\circ]$
$51,05096$	$21,59173$	$1,01794$	$158,56554$
$51,70503$	$21,66539$	$0,50589$	$125,40438$
$52,33383$	$20,69009$	$0,38415$	$330,46451$
$52,92611$	$21,74237$	$1,03065$	$25,73679$
$52,67658$	$20,17984$	$0,84194$	$323,79812$
$51,67071$	$21,77657$	$0,58197$	$124,15296$
$52,83065$	$21,40196$	$0,86607$	$16,28505$



$\psi\,[^\circ]$	$G_r\,[\cdot 10^{12}\cdot\psi\cdot \mathrm{R}]$	$G_h\,[\cdot 10^{12}\cdot\psi\cdot \mathrm{R}]$
$1,01794$	$-12,94773$	$-5,98955$
$0,50589$	$-14,87475$	$-6,31759$
$0,38415$	$-15,88518$	$-6,81493$
$1,03065$	$-12,90351$	$-5,98392$
$0,84194$	$-13,54979$	$-6,04192$
$0,58197$	$-14,48793$	$-6,17260$
$0,86607$	$-13,46849$	$-6,03682$



M [kg]	A [°]	G_r [$\cdot 10^{12} \cdot \psi \cdot$ R]	G_h [$\cdot 10^{12} \cdot \psi \cdot$ R]
122 699 900 000	158, 56554	−12, 94773	−5, 98955
50 141 480 000	125, 40438	−14, 87475	−6, 31759
8 304 866 000	330, 46451	−15, 88518	−6, 81493
151 704 300 000	25, 73679	−12, 90351	−5, 98392
16 312 930 000	323, 79812	−13, 54979	−6, 04192
6 733 962 000	124, 15296	−14, 48793	−6, 17260
14 202 570 000	16, 28505	−13, 46849	−6, 03682

$$\Delta r = \sum_{i=1}^{n} G_{r_i} \cdot M_i \qquad \Delta h_{n,e} = \sum_{i=1}^{n} G_{h_i} \cdot M_i \cdot \left\{ \begin{array}{c} -\cos A \\ -\sin A \end{array} \right\}$$