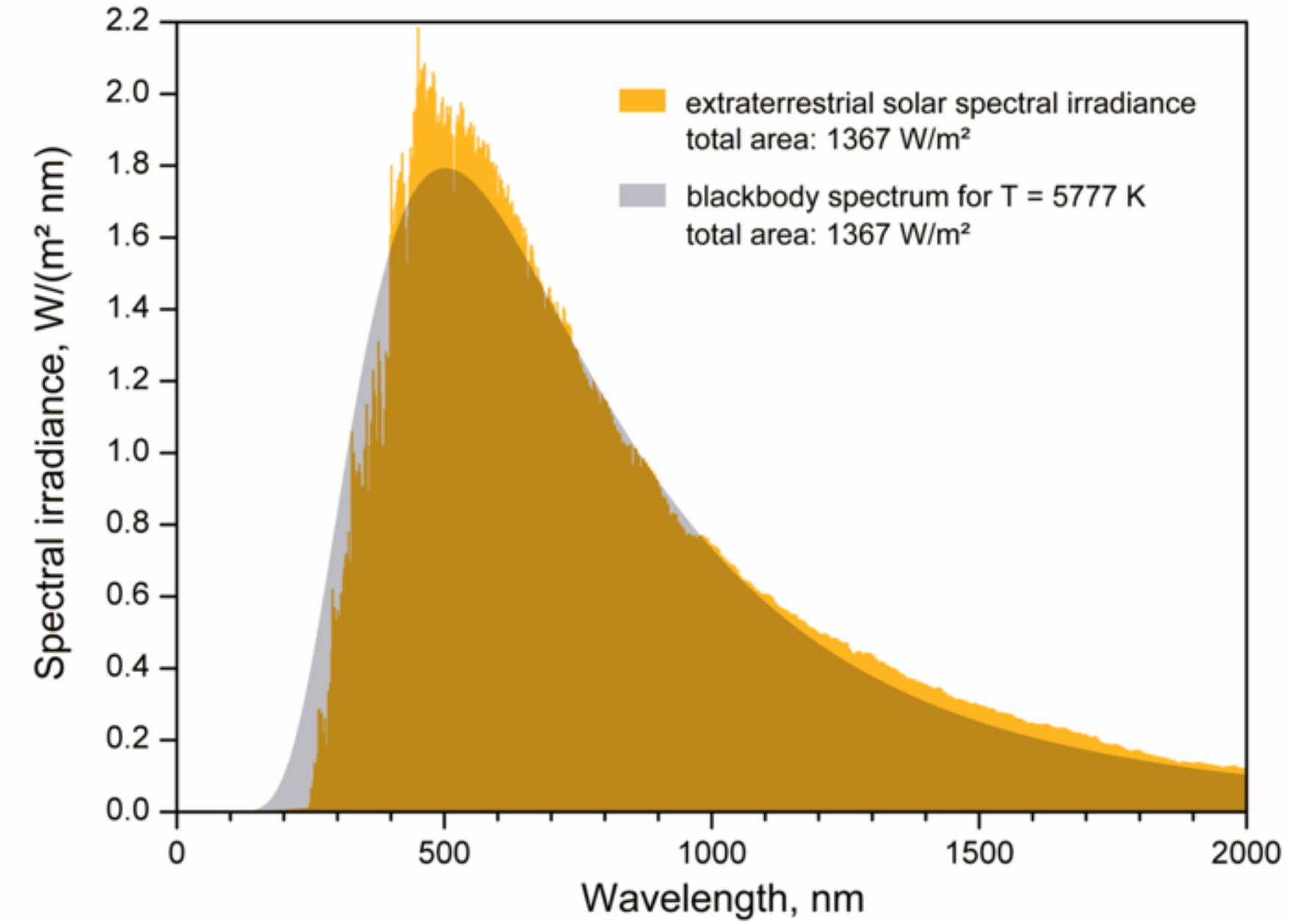
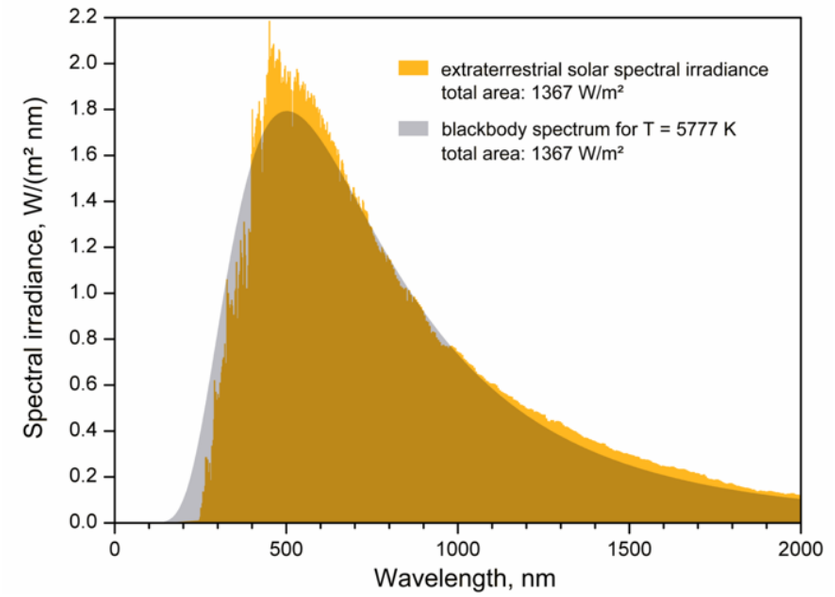
Kvantová mechanika

… včera a dnes

předevčírem

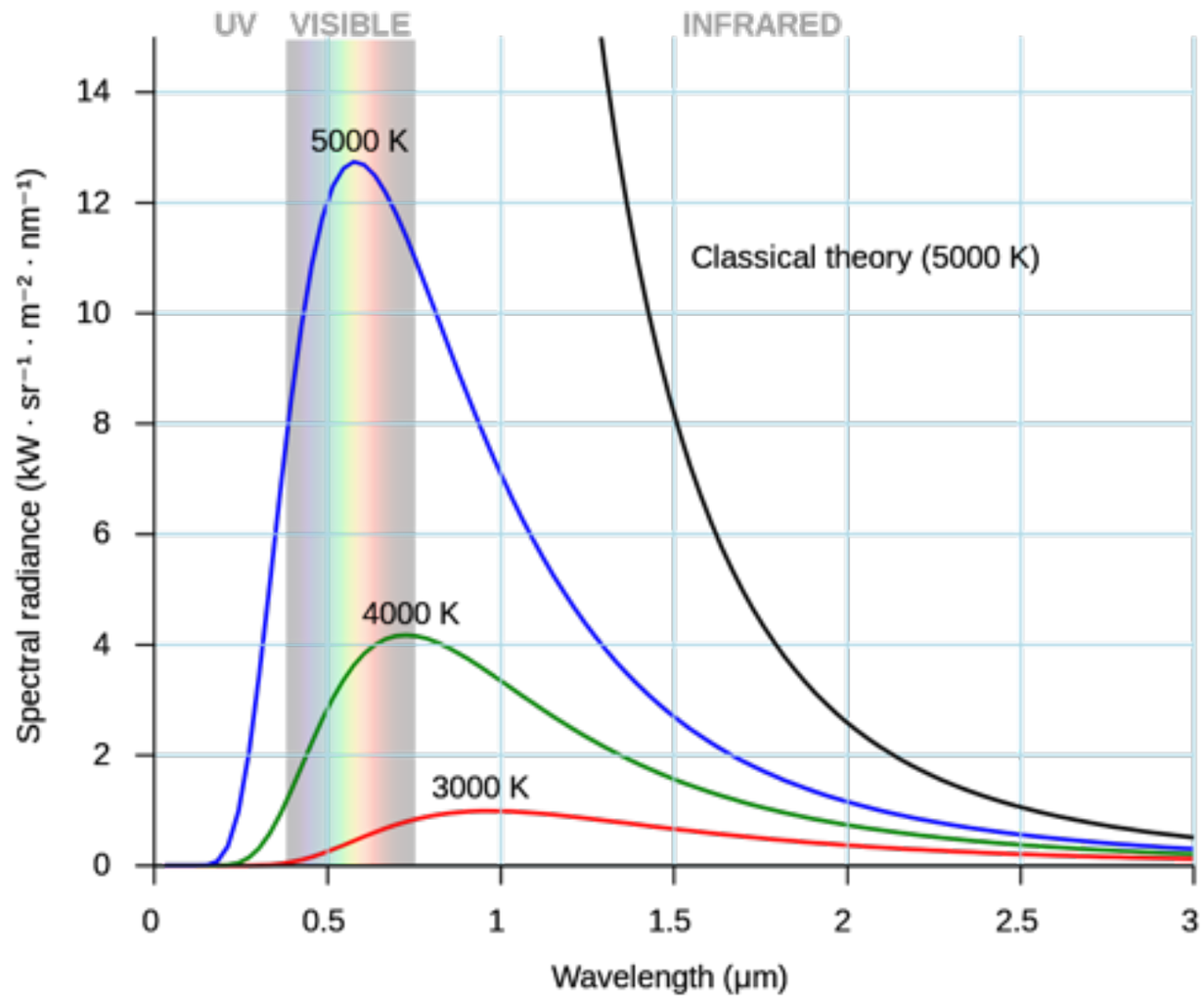


předevčírem



- zákony: Wienův, Rayleigh-Jeans
- Stefan-Boltzmann:

$$q = \frac{2\pi^5 k^4}{15 c^2 h^3} T^4$$



$$P(\lambda) \propto \lambda^{-5}/(e^{a/\lambda} - 1)$$

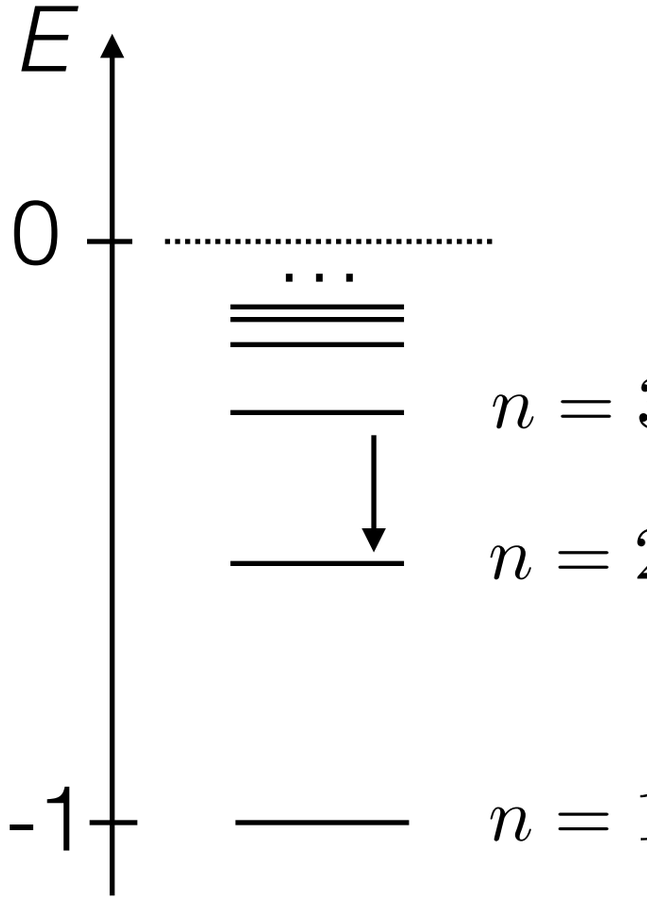
Planck, $a = hc/kT$

včera

$H-\alpha$

$\lambda = 656.3$ nm

(Balmerova série)

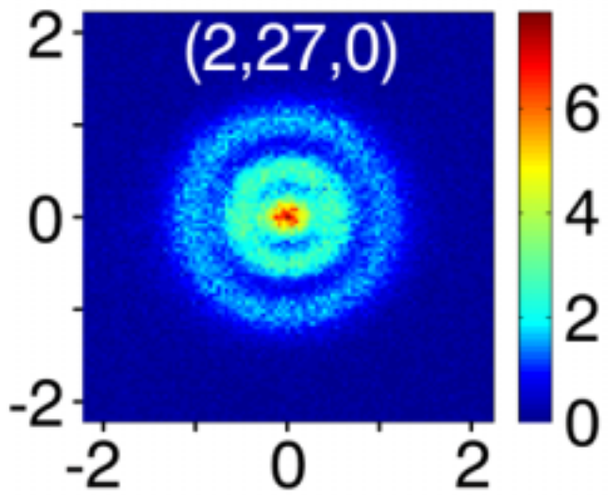


$$\frac{1}{\lambda} = R_\infty \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

- přechody mezi hladinami - n_1, n_2
- vlnová délka vyzářeného fotonu
- Rydbergova konst.

Stodolna et al. ’13

Phys. Rev. Lett. 110, 213001



$$E_n = -\frac{hcR_\infty}{n^2}$$

včera/dnes

$$-\frac{\hbar^2}{2m}\Delta\psi + V\psi = E\psi$$

(Schrödingerova rovnice)

harmonický oscilátor

$$-\frac{\hbar^2}{2m}\psi''(x) + \frac{1}{2}m\omega^2 x^2\psi(x) = E_n\psi(x)$$

- rozměr: 1D
- potenciální energie: parabolická jáma

atom vodíku

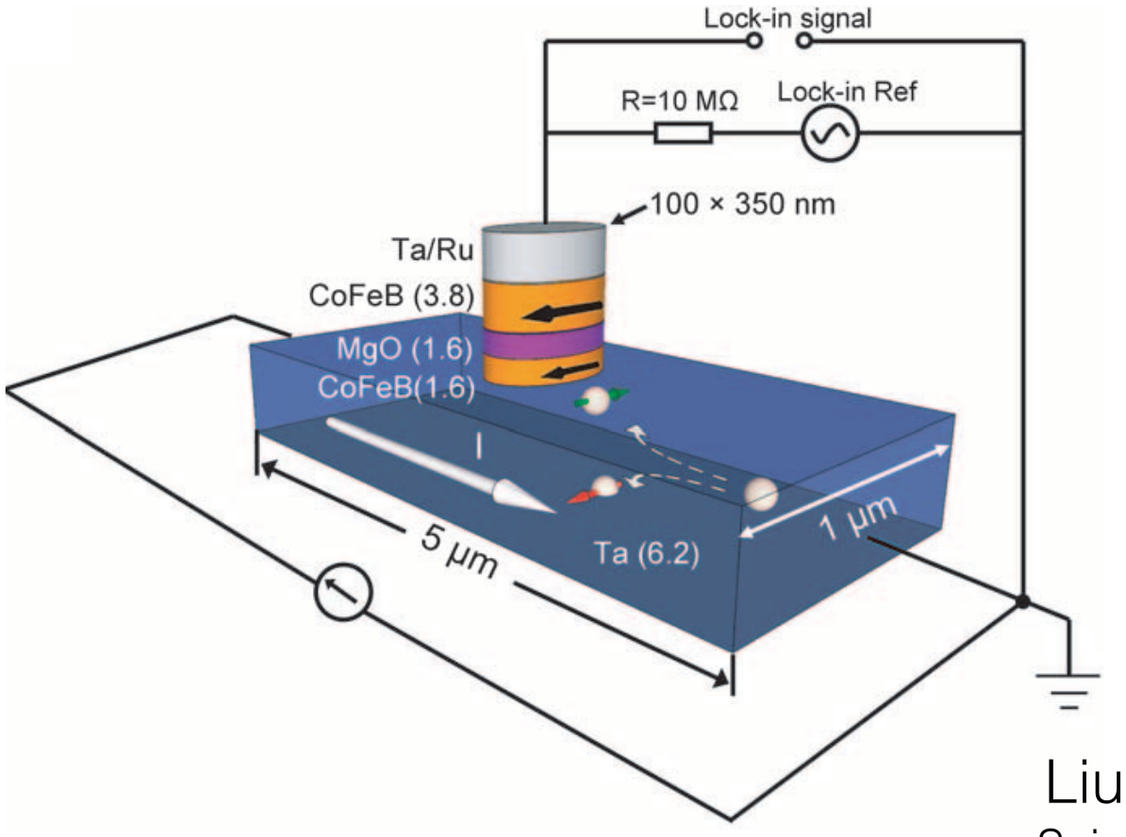
$$-\frac{\hbar^2}{2m}\left(\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2}\right) - \frac{e^2}{4\pi\epsilon}\frac{\psi}{r} = E_n\psi$$

- rozměr: 3D
- potenciální energie: coulombovské 1/r
- speciální značení:

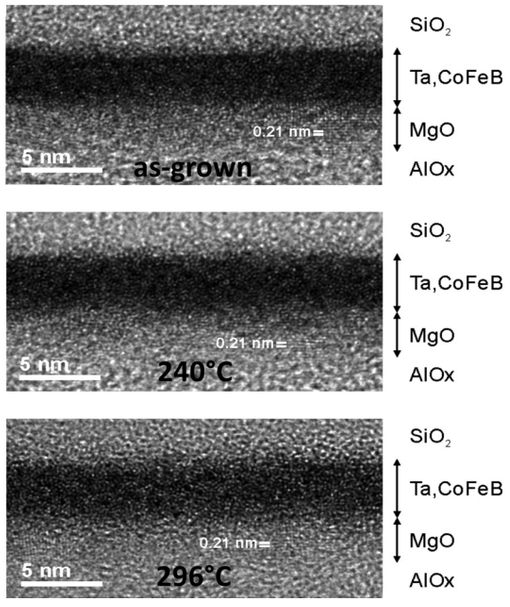
$$\psi = \psi(x, y, z)$$

$$r = \sqrt{x^2 + y^2 + z^2}$$

dnes



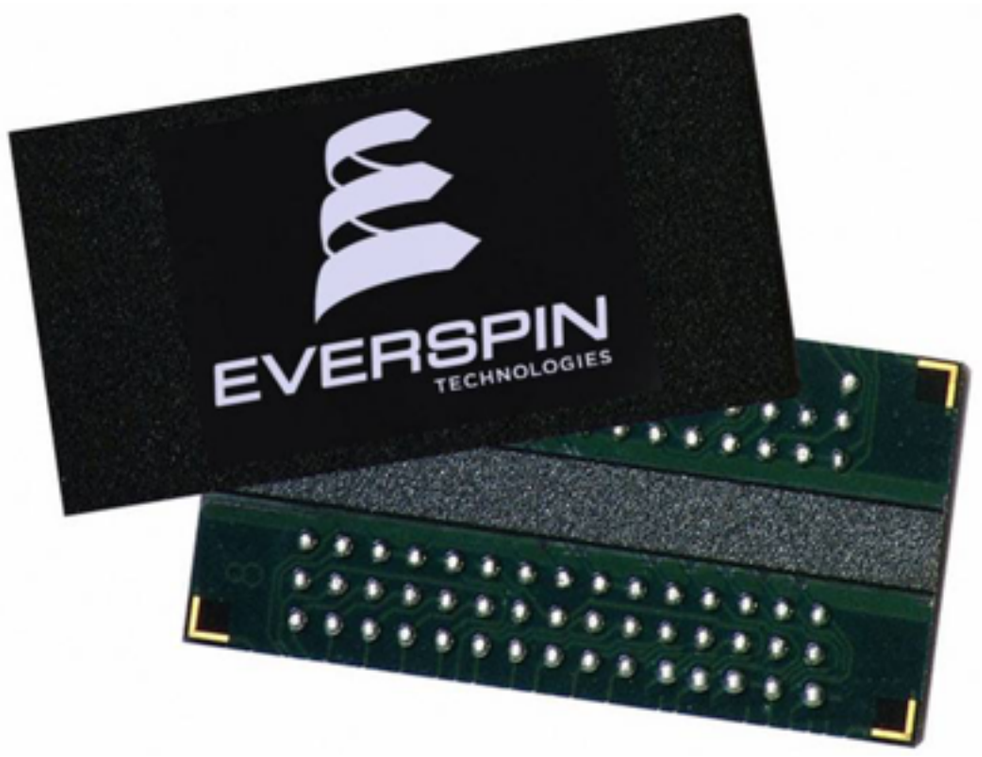
Liu et al. ’12
Science 336, 555



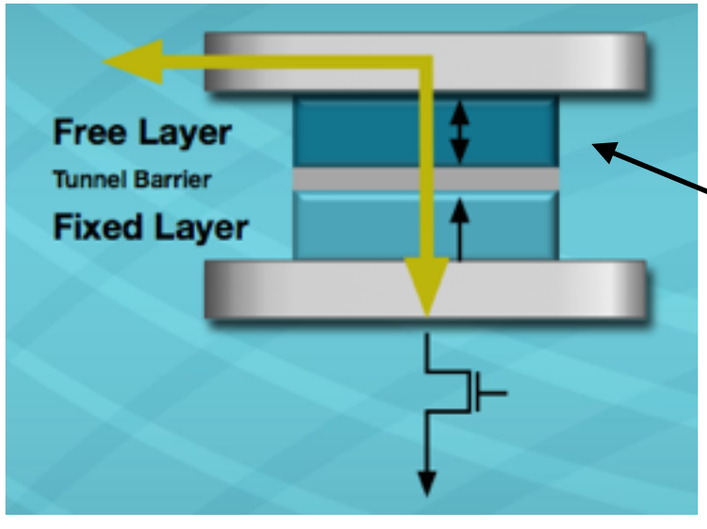
Avci et al. ’14
Phys. Rev. B 89, 214419

Magnetické paměti: HDD a kam dál?

feromagnety:

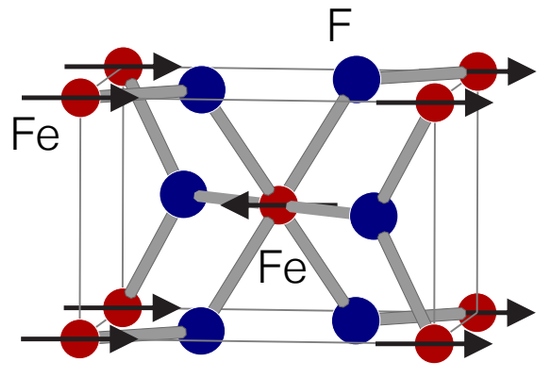


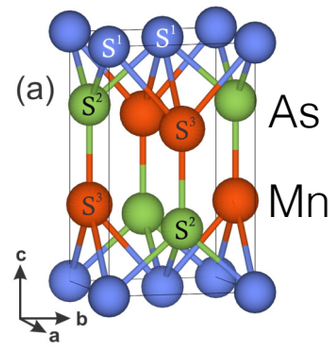
MTJ-based MRAM

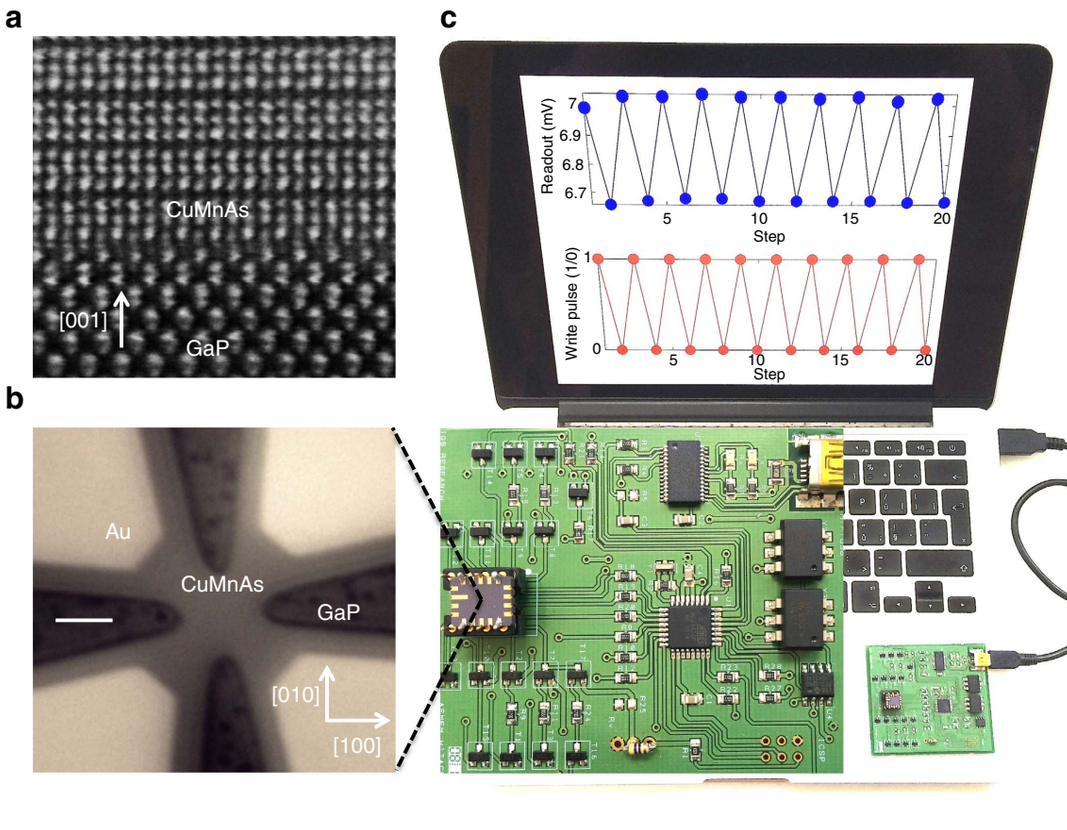


0 or 1: free layer magnetisation direction

antiferomagnety:

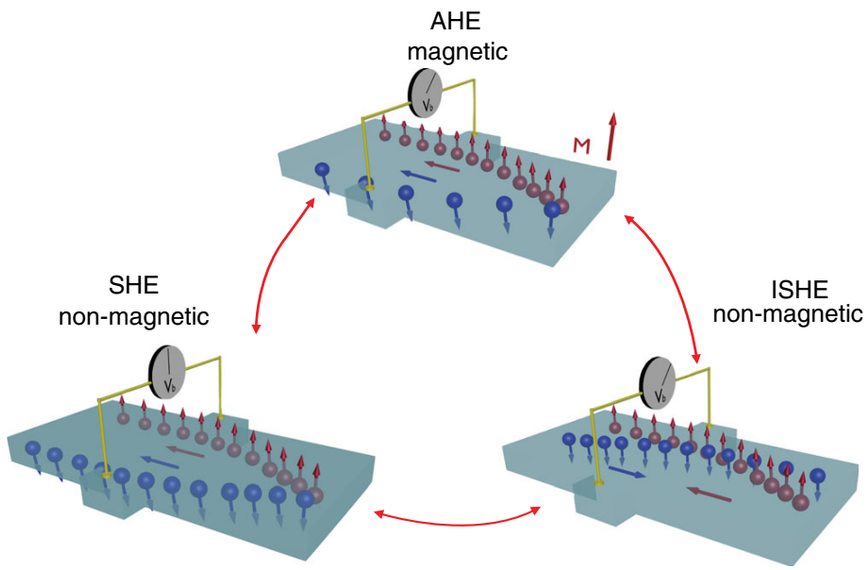






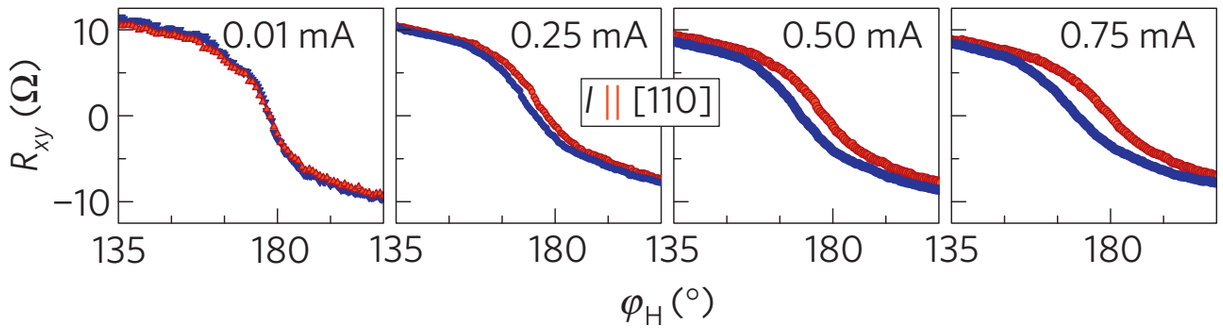
Olejník et al. ’17
[10.1038/ncomms15434]

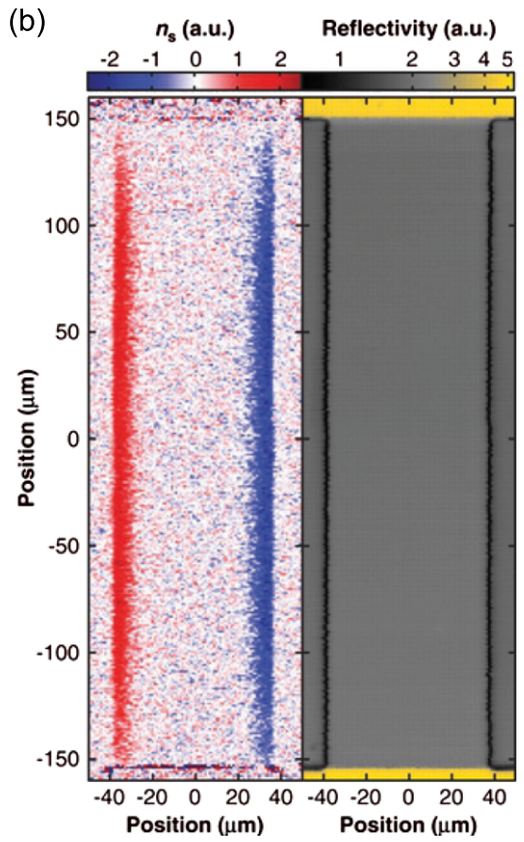
Edelstein effect, spin Hall effect (SHE)



Sinova et al. ’15
Rev. Mod. Phys 87, 1213

Chernyshov et al. ’09
Nature Phys. 5, 656





Kato et al. ’04
Science 306, 1910

spin-orbit interaction

$$H_{SO} = \frac{\hbar}{4m^2c^2}\nabla V \cdot (\vec{p} \times \vec{\sigma}) = \frac{1}{2m^2c^2}\frac{1}{r}\frac{dV}{dr}\vec{L} \cdot \vec{S}$$

… a ještě naposledy

(Schrödingerova rovnice)

$$\hat{H}|\psi\rangle = E|\psi\rangle$$

$$-\frac{\hbar^2}{2m}\Delta\psi + V\psi = E\psi$$

diferenciální rovnice

$$\begin{pmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{pmatrix} \begin{pmatrix} \psi_1 \\ \psi_2 \end{pmatrix} = E \begin{pmatrix} \psi_1 \\ \psi_2 \end{pmatrix}$$

maticová rovnice