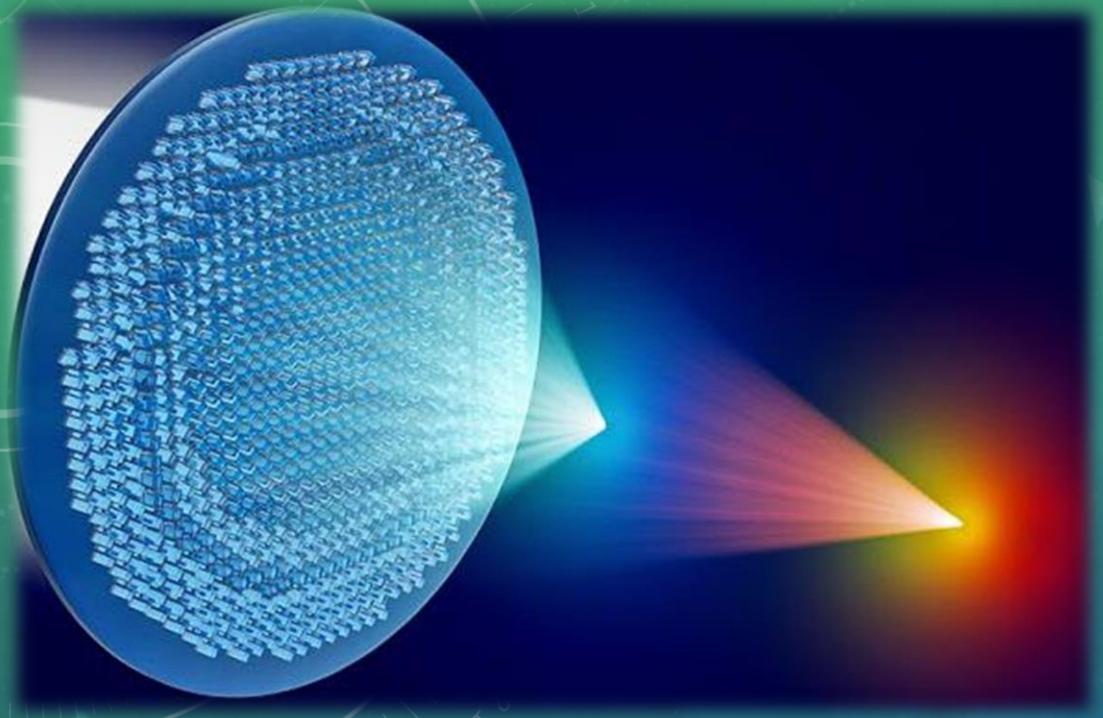


OPTIČNE METALEČE

MATIC TONIN
MENTOR: DANIEL SVENŠEK

UVOD

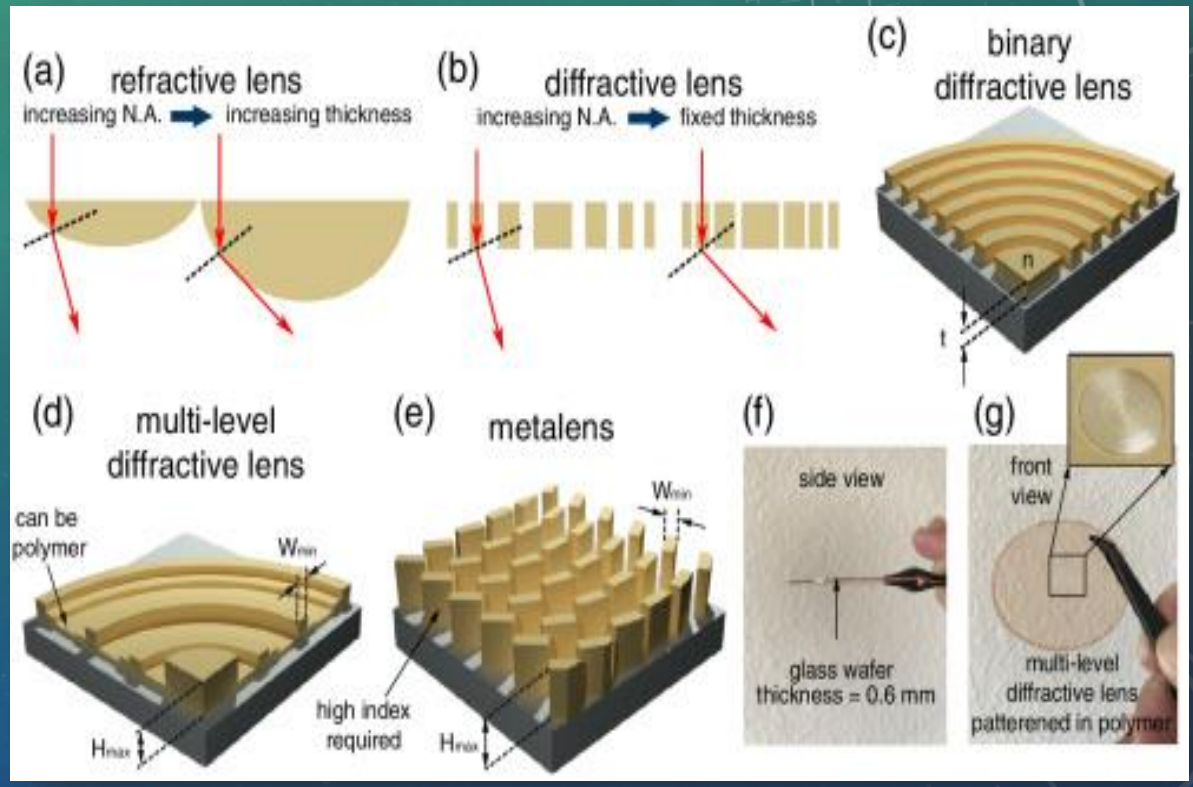
Razvoj optičnih naprav:

a) Steklene leče

b) Uklonska režica

c) Krožna uklonska reža ali uklonska leča

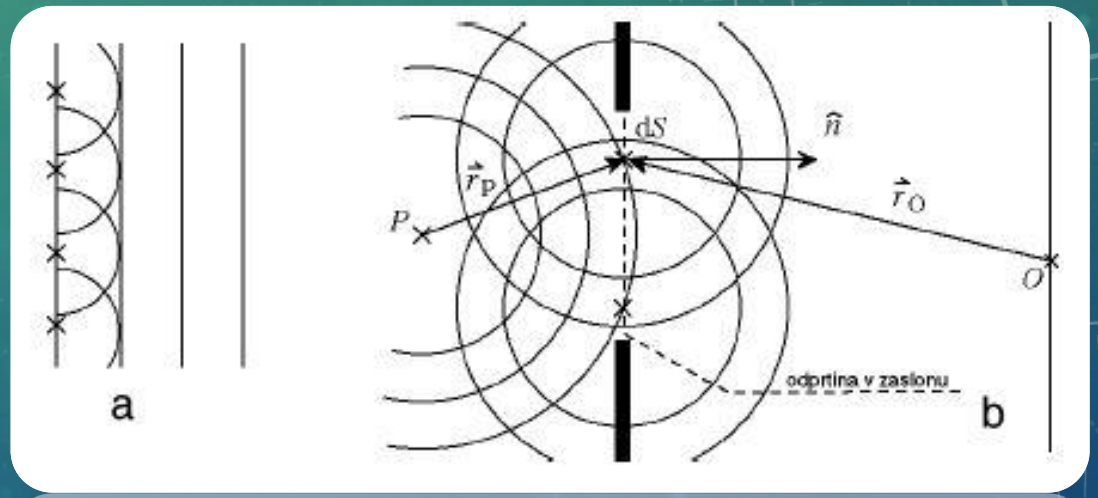
d) večslojne uklonske mrežice, Multilevel diffractive lenses ali MDLs



OSNOVE OPTIČNIH POVRŠIN

Amplituda svetlobe, ki seva iz točkastega izvora, ustreza rešitvam Helmholtzeve enačbe:

$$\nabla^2\psi + k^2\psi = \delta(\mathbf{r}) \quad \psi(r) = \frac{e^{ikr}}{4\pi r}$$



Ko valovna fronta naleti na zaslon z odprtino nastane nova valovna fronta z ampitudo:

$$\Psi(r) \propto \iint_{\text{Rea}} E_{\text{inc}}\ (x', y')\ \frac{e^{ik|\mathbf{r}-\mathbf{r}'|}}{4\pi\,|\mathbf{r}-\mathbf{r}'|} dx'dy'$$

V primeru dvodimenzionalne krožne odprtine:

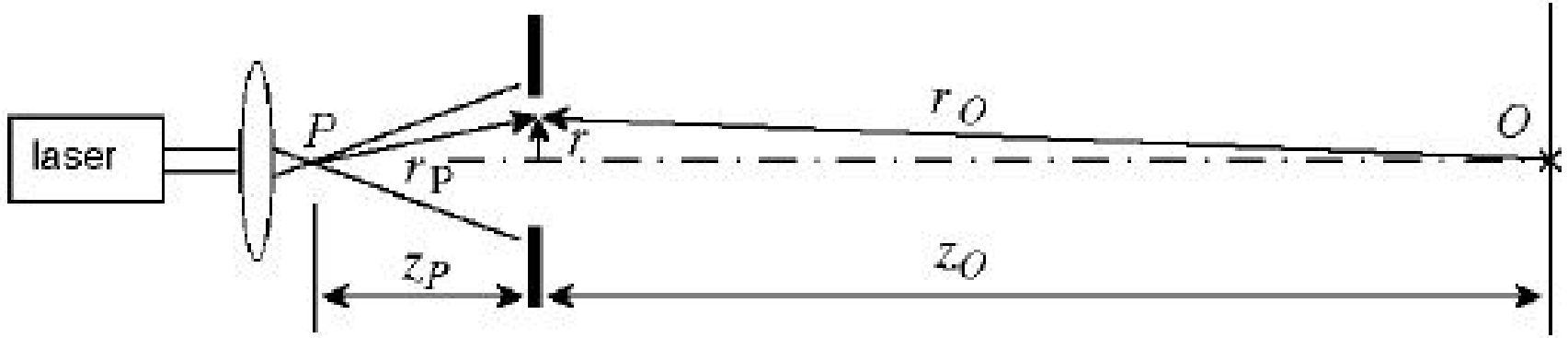
$$\Psi \propto \frac{e^{ikr_p}}{4\pi r_p} \iint_{\mathrm{Rea}} E_{\mathrm{inc}} \frac{E^{ikr_o}}{r_o} \mathrm{d}S$$

Za fazno razliko si moramo pogledati razliko optičnih poti.

$$(r_p + r_o) - (z_o + z_p) = m\frac{\lambda}{2}$$

Tako velja:

$$\Delta\phi = \frac{kr^2}{2f}$$



GORIŠČNA RAZDALJA

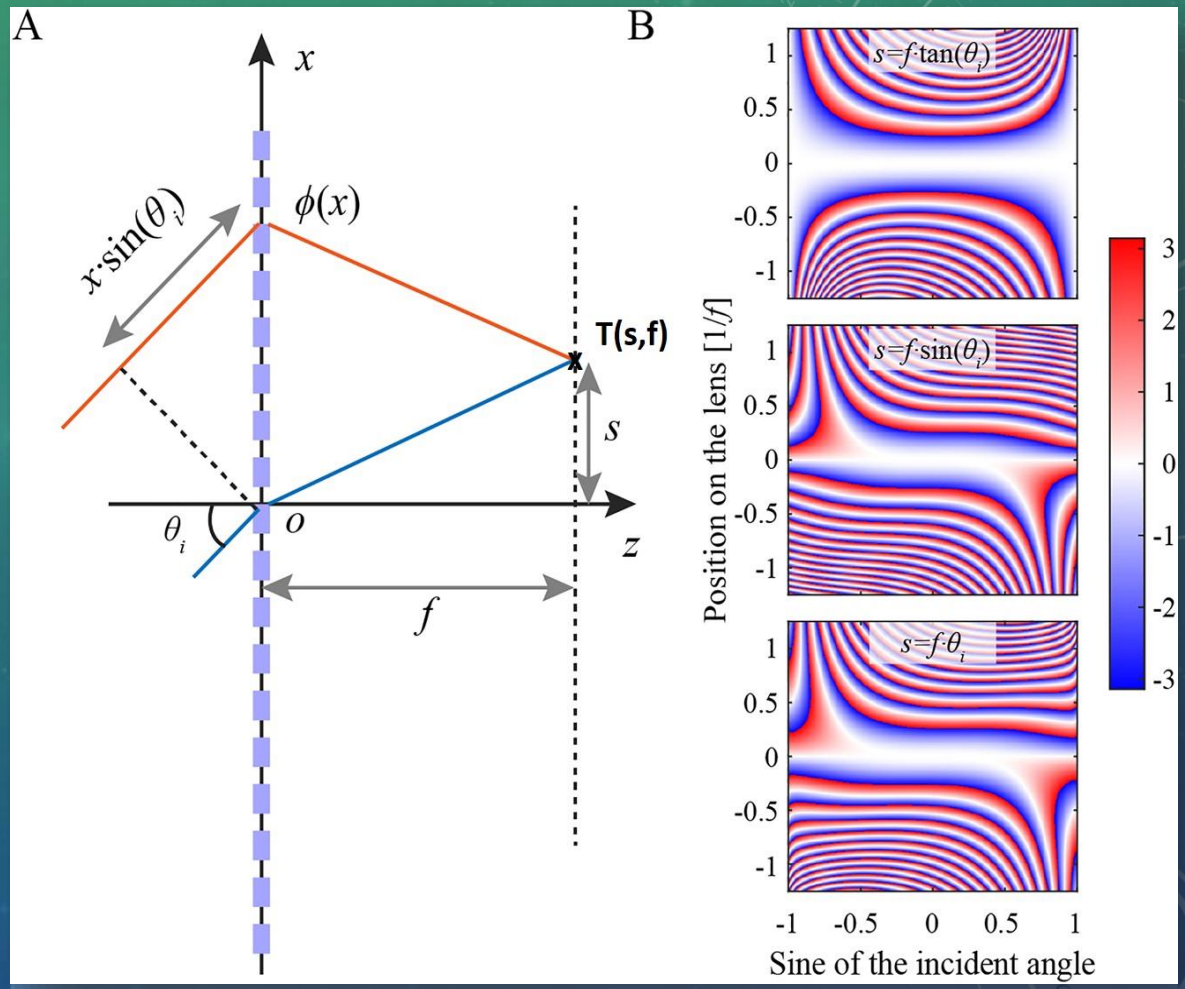
HIPERBOLIČNI FAZNI PROFIL

Ko svetloba vpade pravokotno na lečo je razlika med optičnima potema enaka

$$\phi(x) = -k\left(\sqrt{x^2 + f^2} - f\right)$$

Ko svetloba vpade pod določenim kotom in se žarki zberejo v točki T(s,f) je:

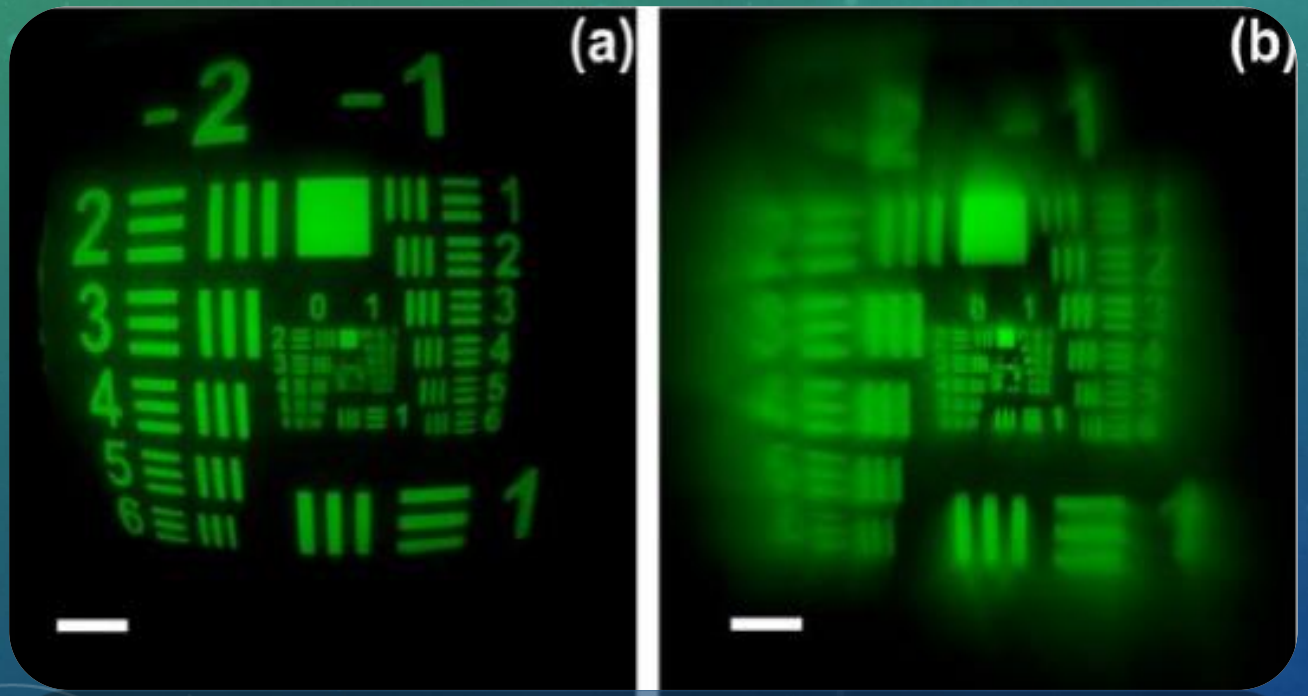
$$\phi\left(\theta_{\mathrm{i}}\right) = -k_0\left[x\sin\theta_{\mathrm{i}} + \sqrt{\left(x - s\left(\theta_{\mathrm{i}}\right)\right)^2 + f^2} - \sqrt{\left(s\left(\theta_{\mathrm{i}}\right)\right)^2 + f^2}\right]$$

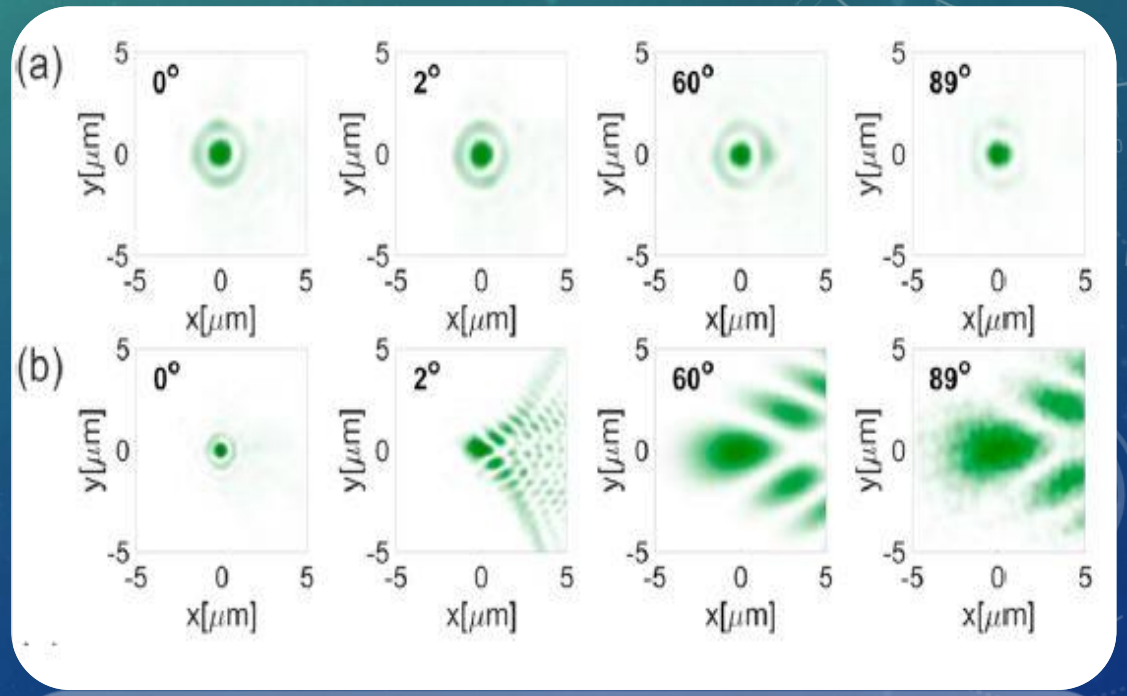


KVADRATIČNI FAZNI PROFIL

Z upoštevanjem, da kot ni majhen iz enačbe krogelne reže sledi

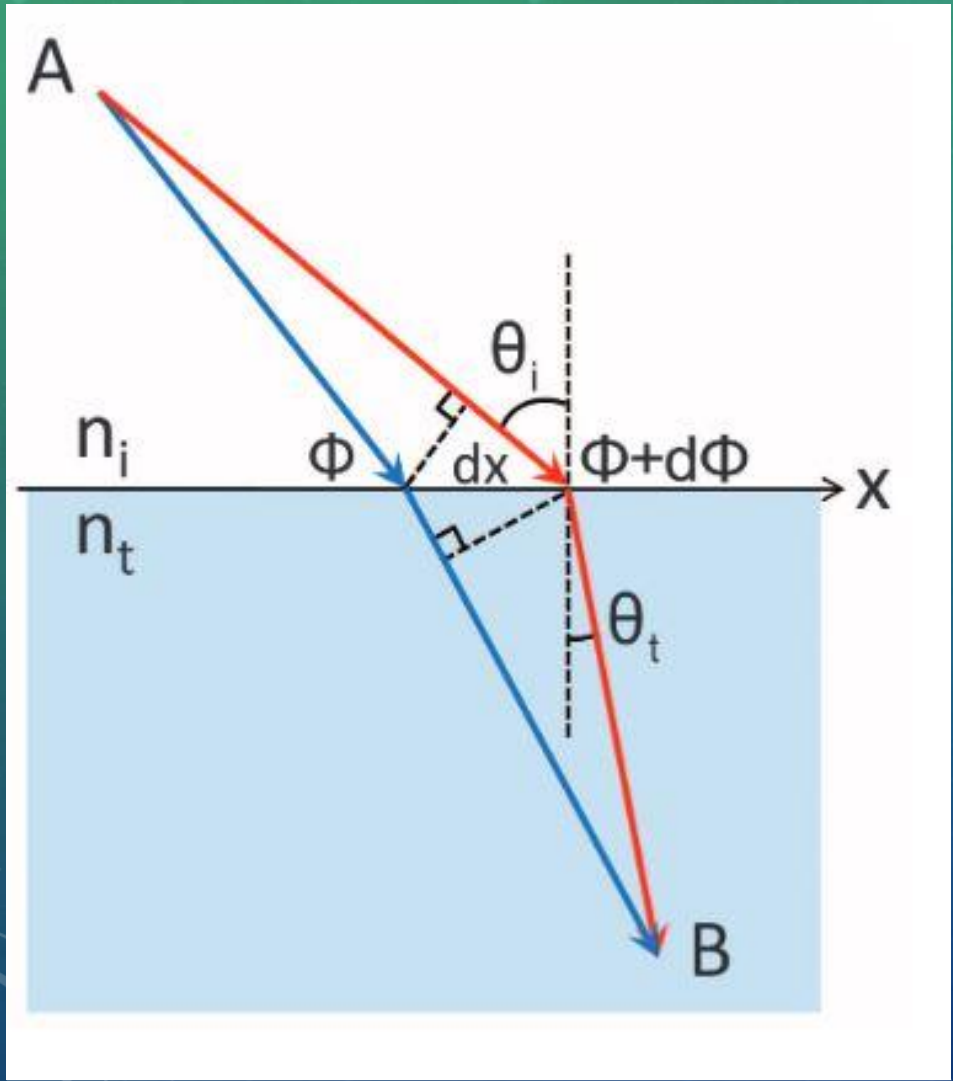
$$\phi\left(r,\theta_{\mathrm{i}}\right)=-\frac{k_0}{2f}r^2-k_0x\sin\theta_{\mathrm{i}}=-\frac{k_0}{2f}\left[\left(x+f\sin\theta_{\mathrm{i}}\right)^2+y^2\right]+\frac{k_0f\sin^2\theta_{\mathrm{i}}}{2}$$





FAZA IN INTERFERENCA

POSPLOŠENI LOMNI ZAKON



Ko se bosta dana žarka po prehodu v snov srečala v točki B, bosta ustvarila konstruktivno interferenco takrat, ko je razlika njunih faz enaka 0:

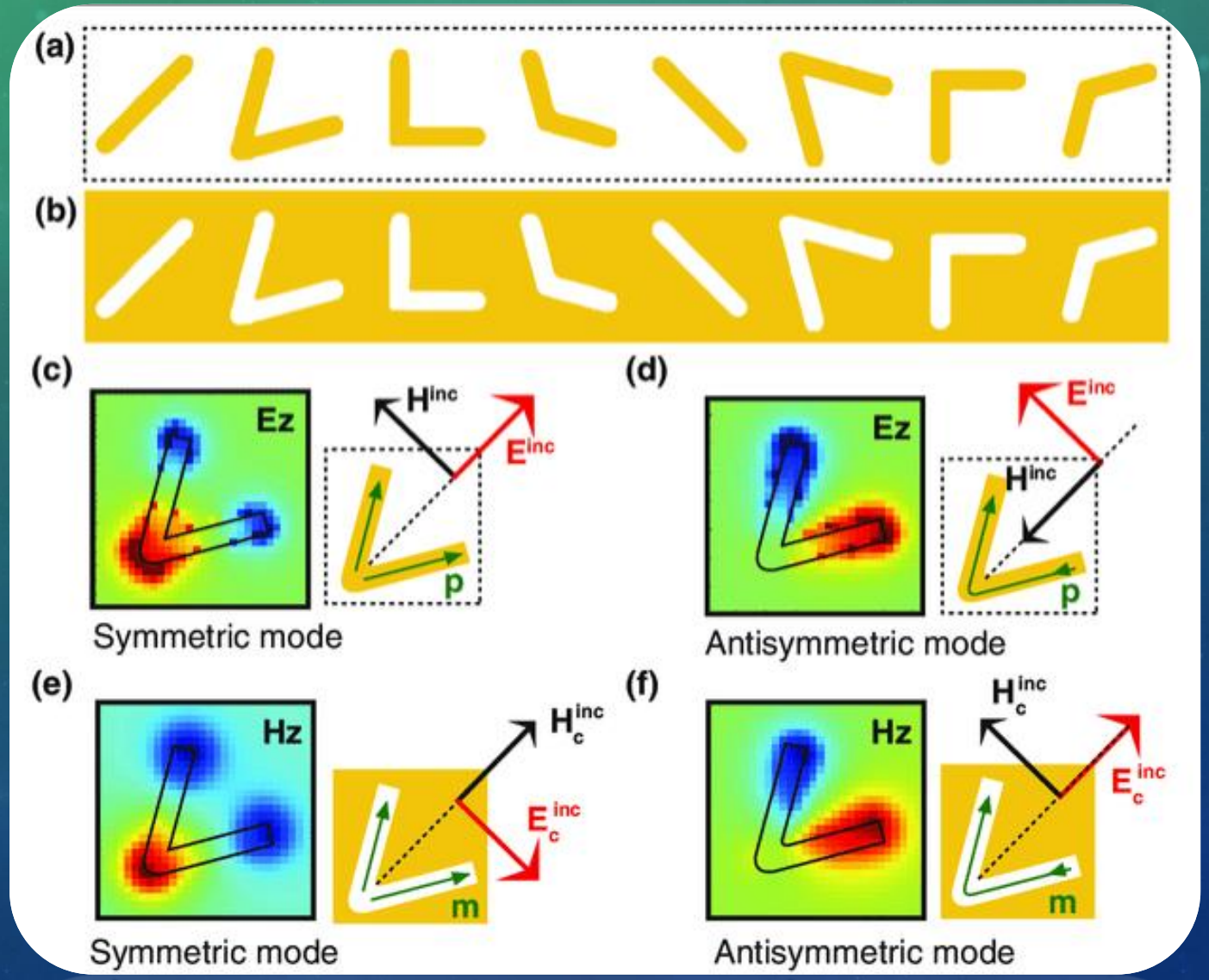
$$[k_0 n_i \sin(\theta_i)\mathrm{d}x + (\Phi + \mathrm{d}\Phi)] - [k_0 n_t \sin(\theta_t)\mathrm{d}x + \Phi] = 0$$

Če enačbo preuredimo, dobimo posplošeni lomni zakon ali generaliziran Snellov zakon.

$$\sin(\theta_\mathrm{t})\, n_\mathrm{t} - \sin(\theta_\mathrm{i})\, n_\mathrm{i} = \frac{\lambda_\mathrm{o}}{2\pi}\frac{d\Phi}{dx}$$

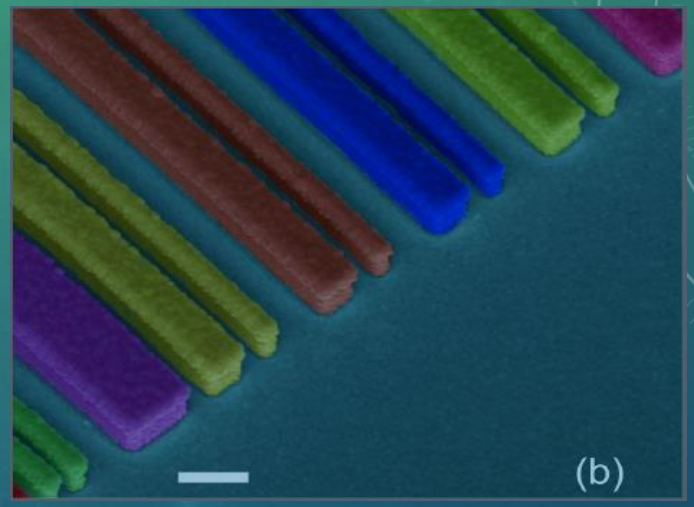
USTVARJANJE FAZE Z NANOSTRUKTURAMI

Primer, nanoantene oblike črke V z dvema nihajnima načinoma; simetričnim in antisimetričnim



PREPROSTA IZDELAVA METALEČ-PRIMERI

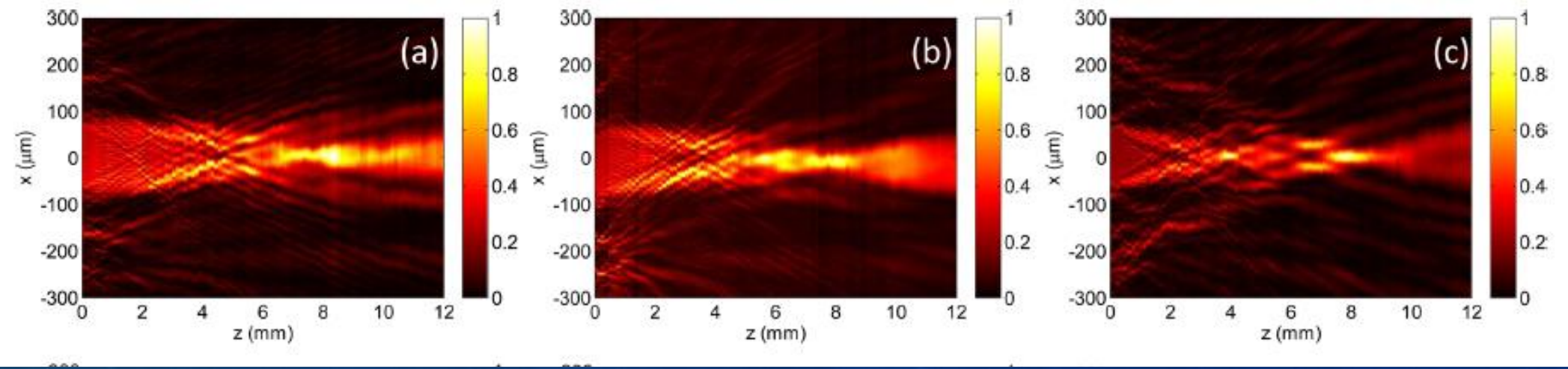
Horizontalna postavitev treh metaleč, ki zbirajo svetlobo valovnih dolžin 1300 nm, 1550 nm in 1800 nm.



1300 nm

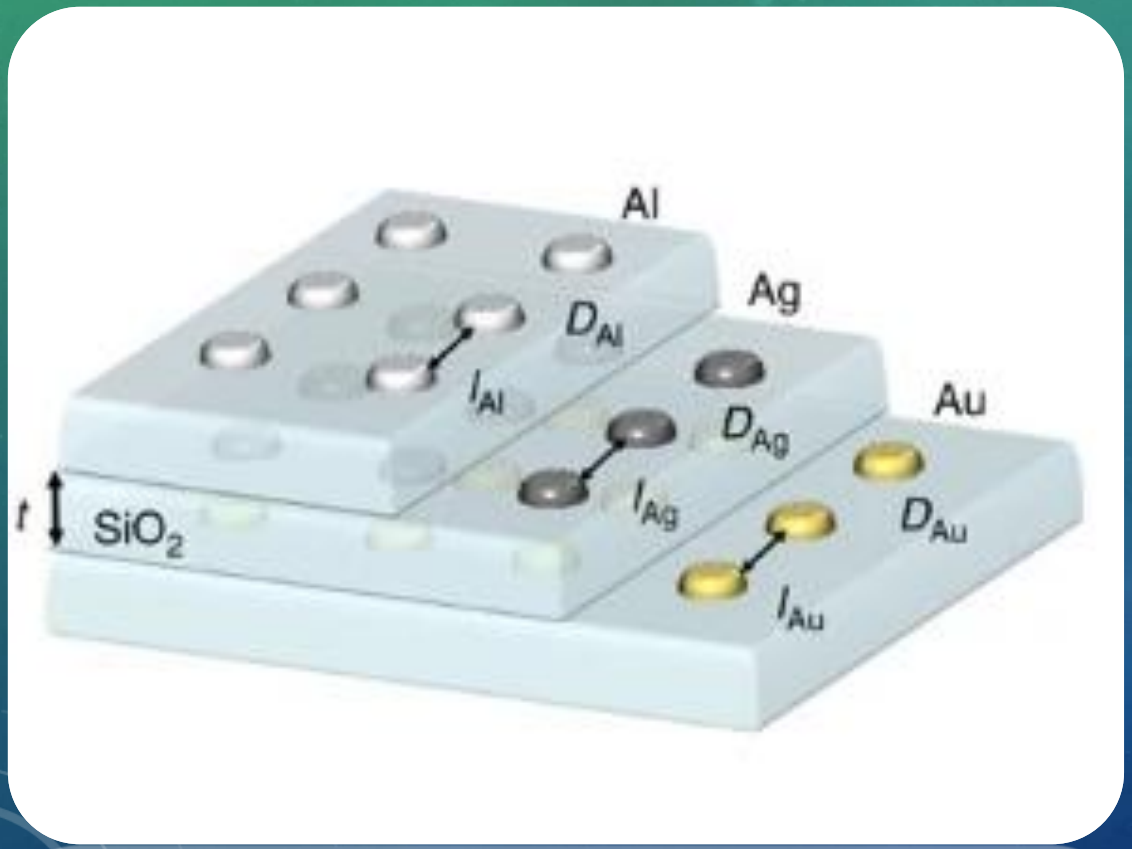
1550 nm

1800 nm



PREPROSTA IZDELAVA METALEČ-PRIMERI

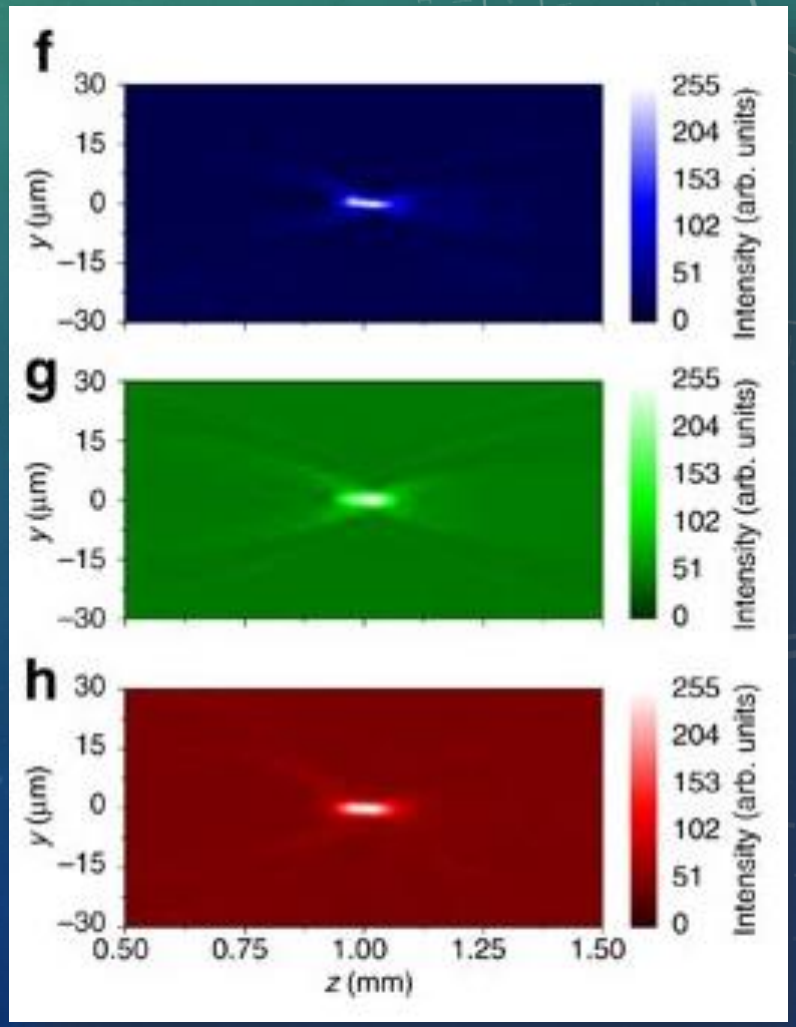
Vertikalna postavitev treh metaleč, ki zbirajo svetlobo valovnih dolžin 650 nm, 550 nm in 450 nm.



450 nm

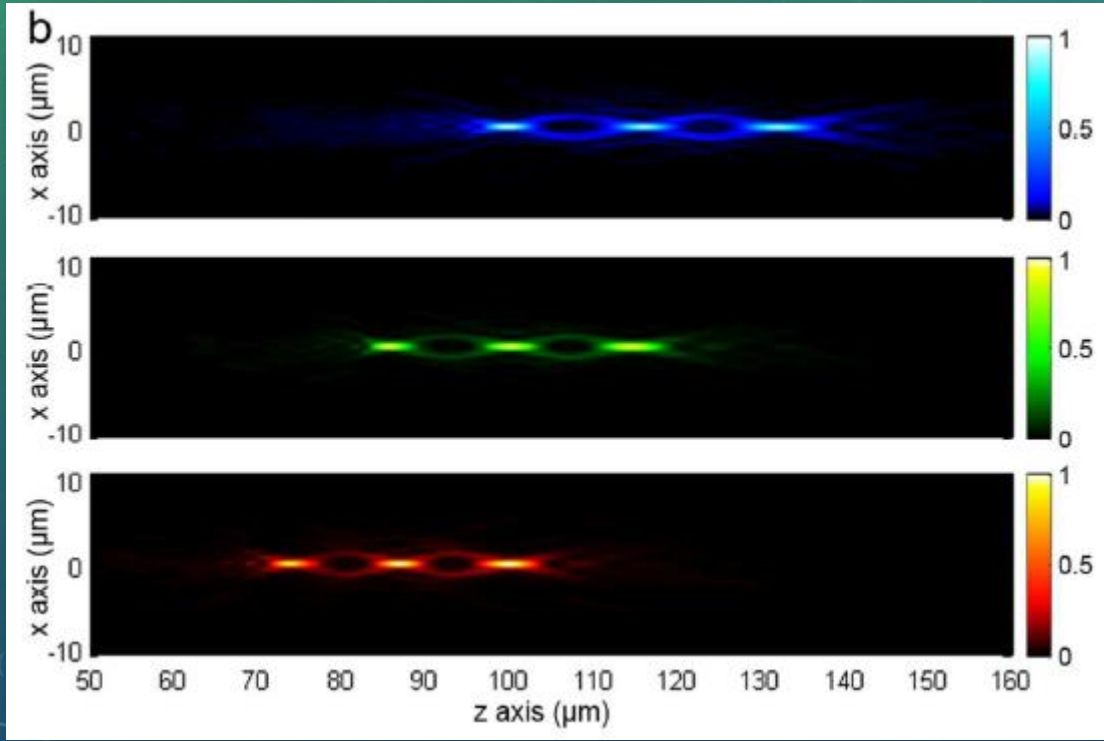
550 nm

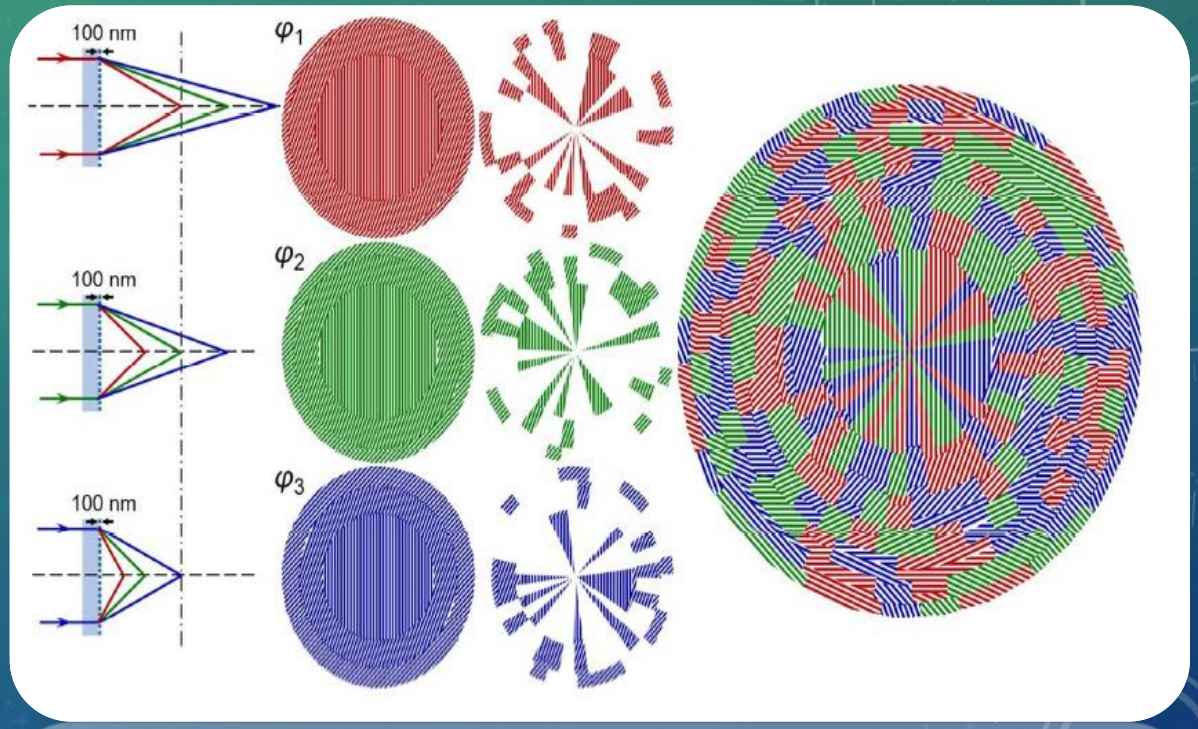
650 nm



PREPROSTA IZDELAVA METALEČ-PRIMERI

Sestavljena leča iz treh metaleč, ki zbirajo svetlobo valovnih dolžin 480, 550 in 620 nm.

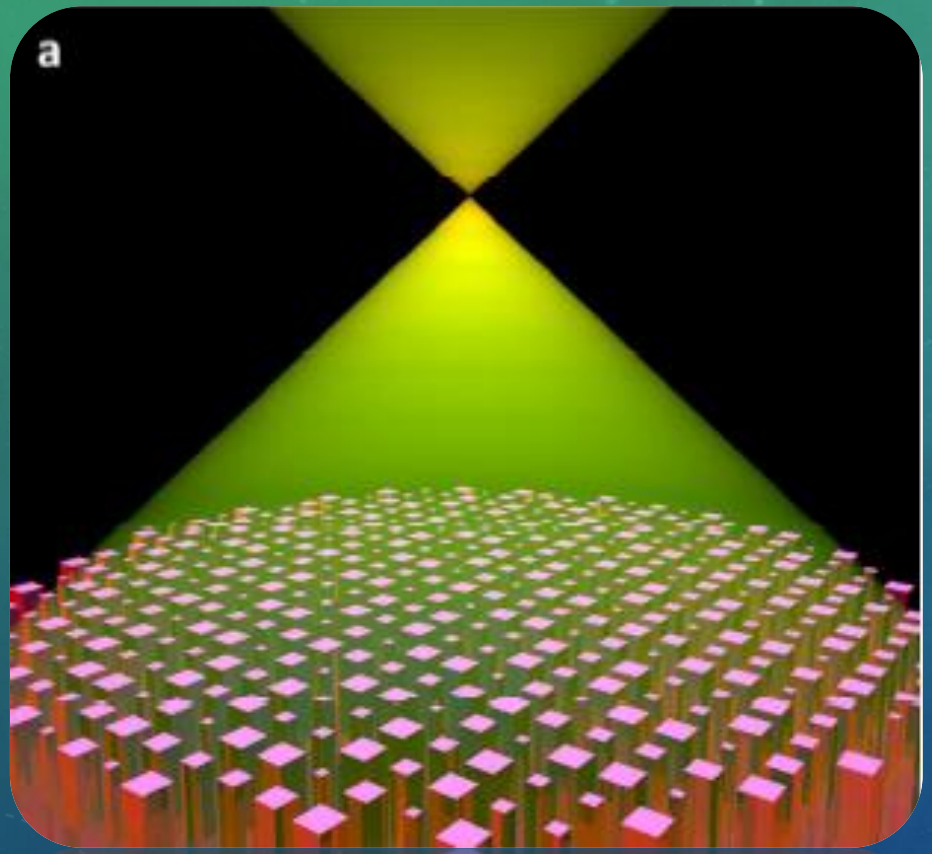




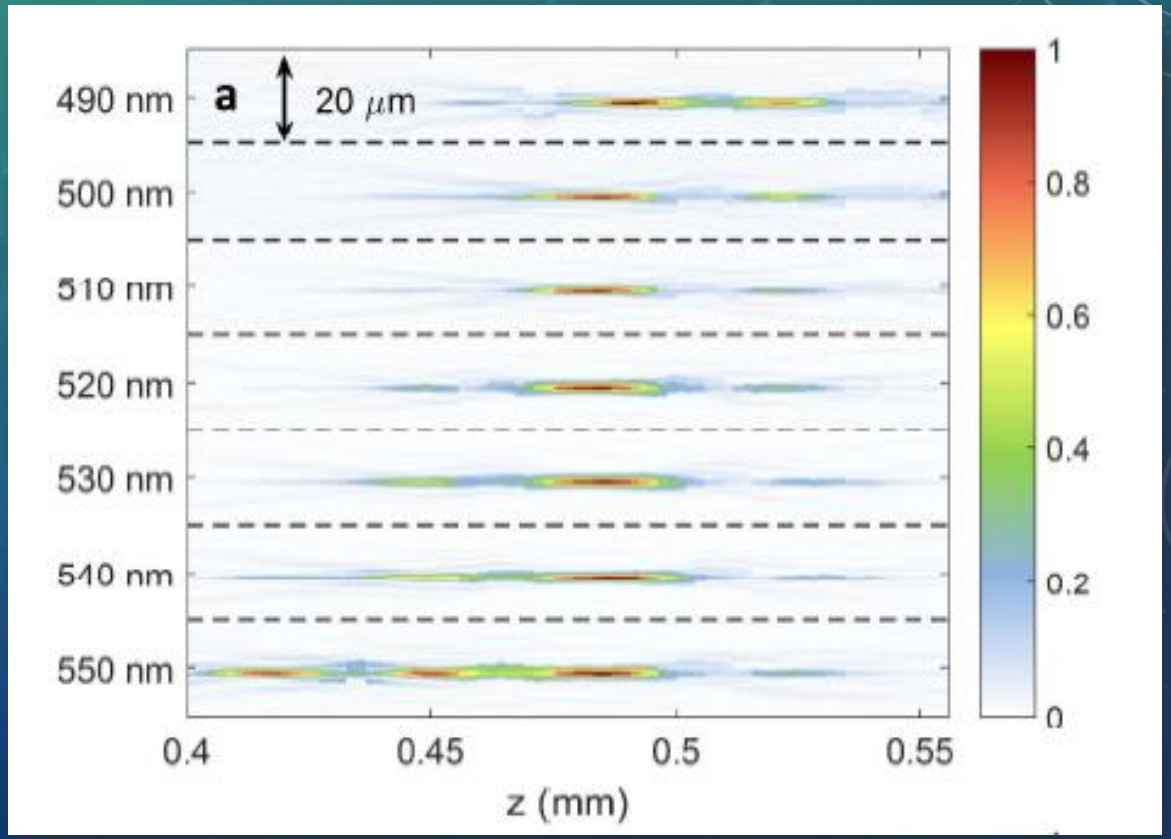
480 nm zgoraj, 550 nm v sredini, 620 nm spodaj

PREPROSTA IZDELAVA METALEČ-PRIMERI

Primer zbiranja svetlobe spektra valovni dolžin-akromatično zbiranje svetlobe.

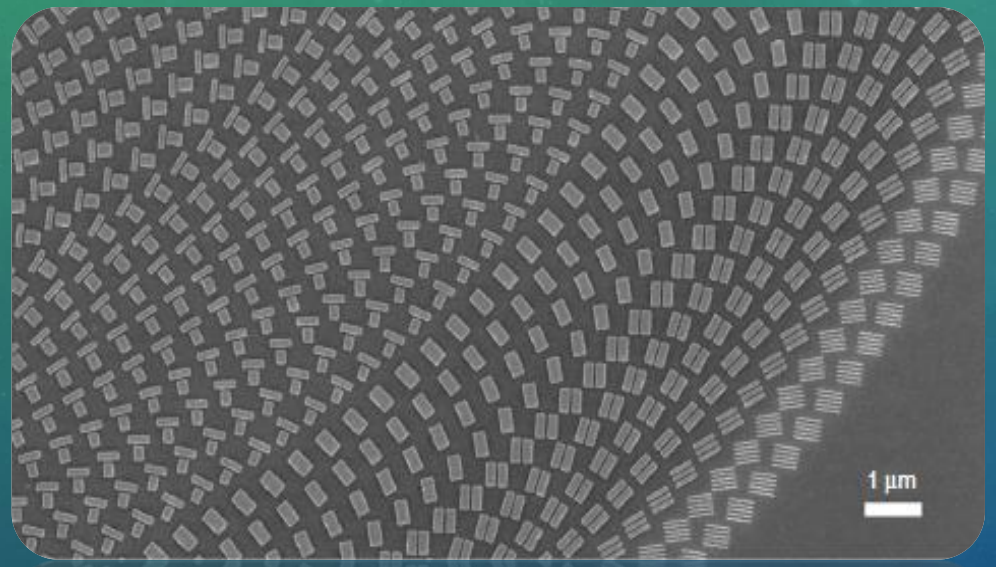


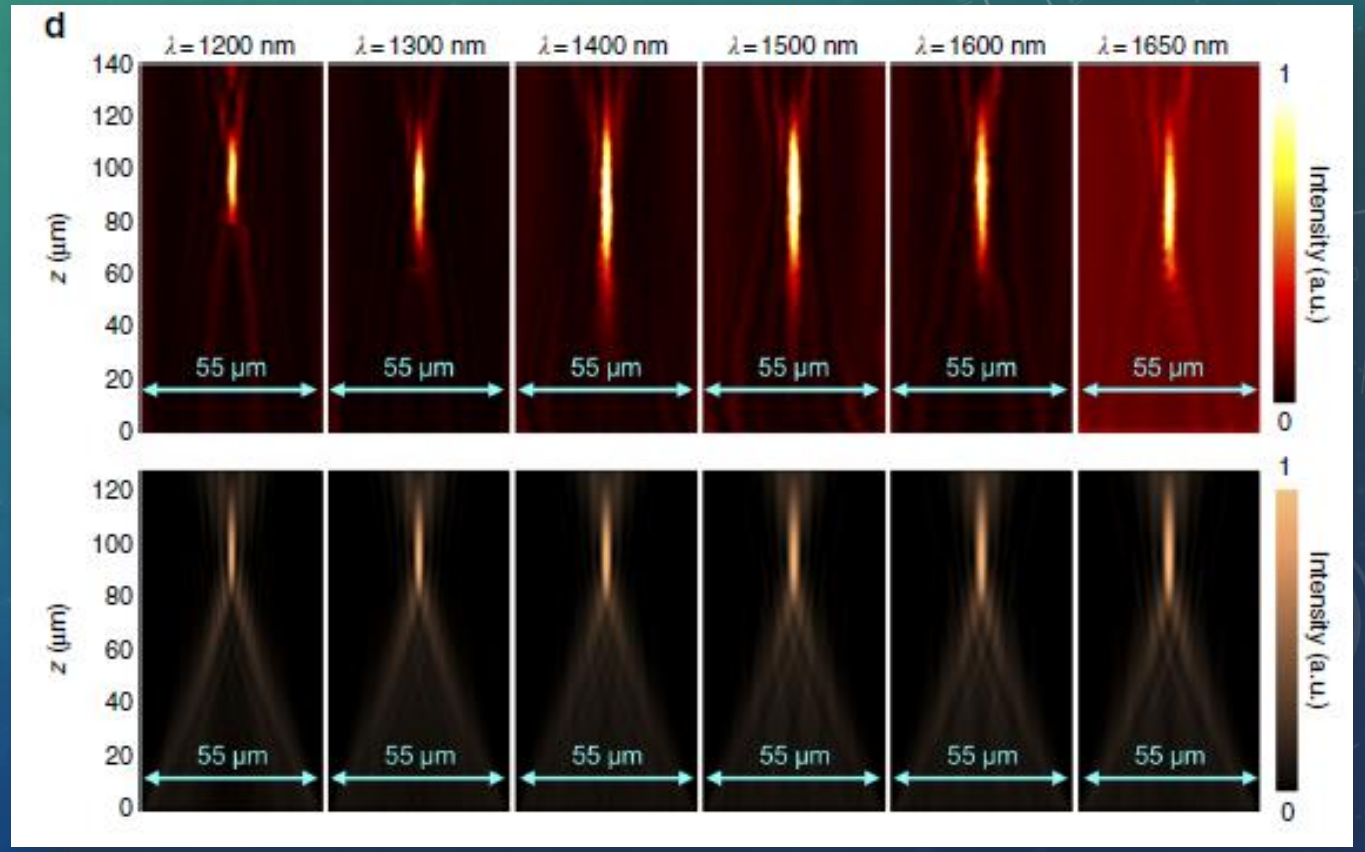
Leča je sestavljena iz stolpcev titanovega dioksida.



PREPROSTA IZDELAVA METALEČ-PRIMERI

Primer zbiranja svetlobe spektra valovni dolžin-akromatično zbiranje svetlobe.





UPORABA V PRAKSI-SLIKANJE

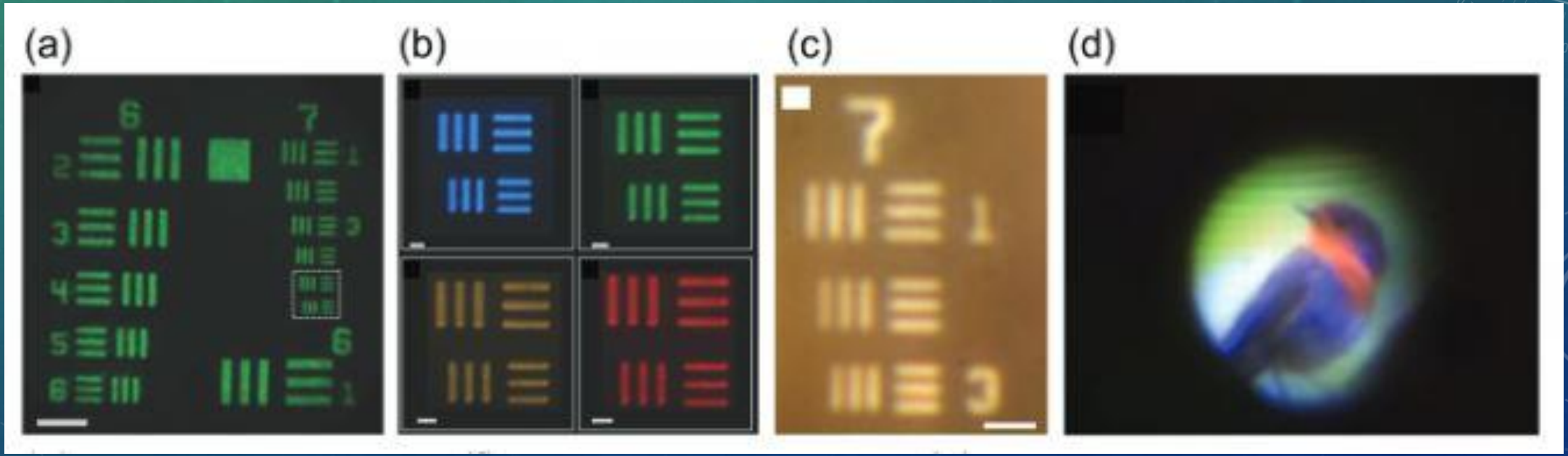
Metaleče se zaenkrat tako dobremu lečenju kot oko še niso približale, problem je predvsem v absorpciji.

Številčnica velikosti 40 nm

Slikana z TiO2 metalečo

Slikana z GaNi metalečo

Slika ptice z GaNi metalečo

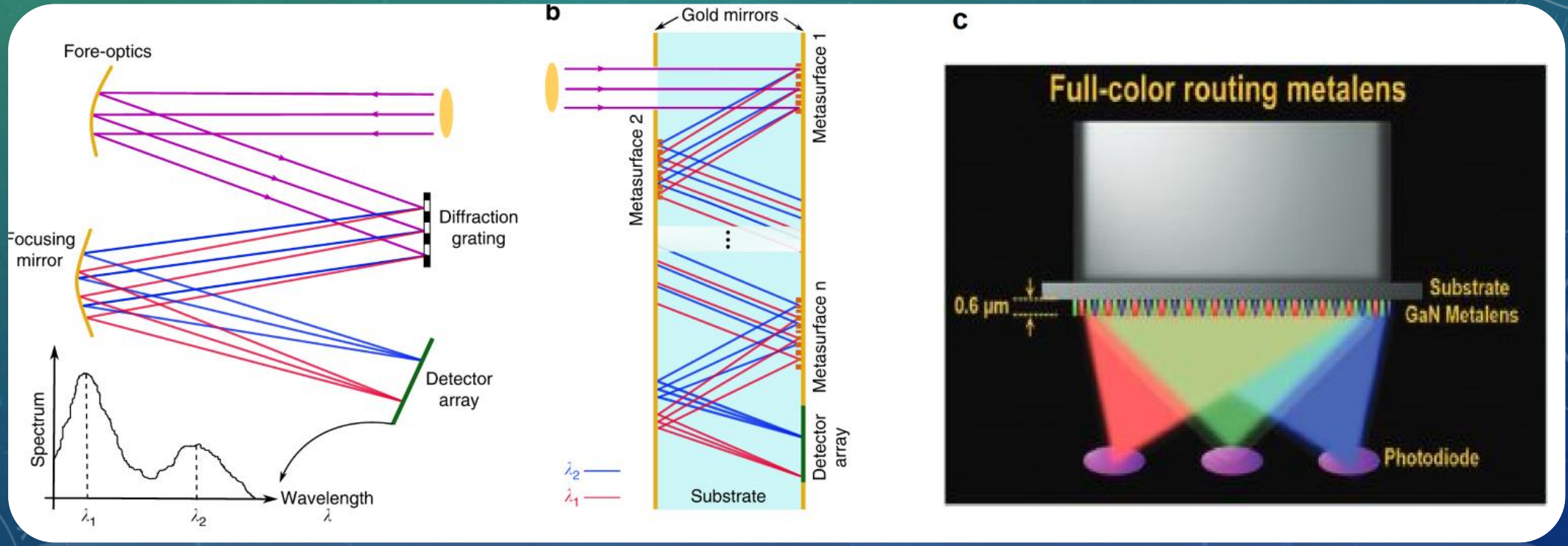


UPORABA V PRAKSI-SPEKTROSKOPIJA IN RGB FILTRI

Primer navadnega spektrometra.

Primer spektrometra z metalečo.

Primer uporabe metaleče v RGB detektorju.



HVALA ZA VAŠO POZORNOST.

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