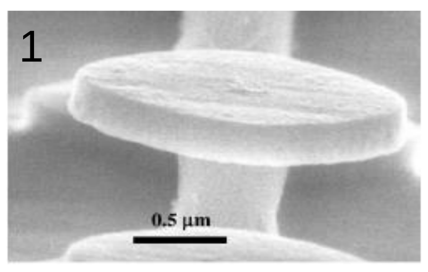
OWTNM'05

8-9 April, Grenoble, France

# IMPROVEMENT OF DIRECTIONALITY OF LIGHT EMISSION FROM TWO OPTICALLY COUPLED MICRODISK LASERS

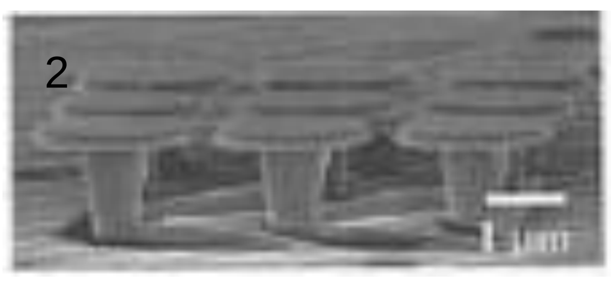
## Object of research

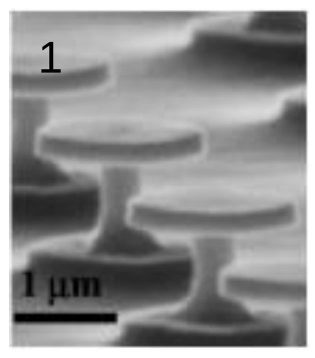
Photonic molecule
in form of optically coupled
semiconductor microdisks

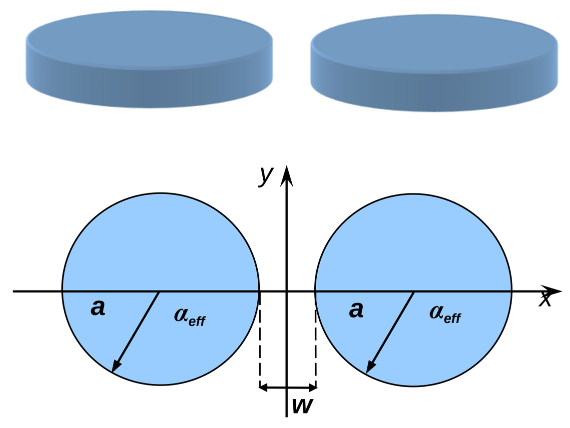




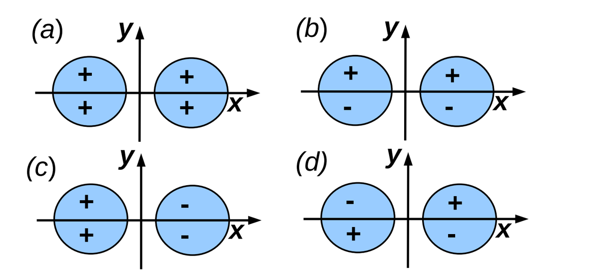
[1]Petter et al., *Appl. Phys. Letts.* Vol.81, No 4, pp.592-594
[2]Nakagawa et al., *Int. Symp. Photonic and Electromagnetic Crystal Structures, Kyoto, 2004*

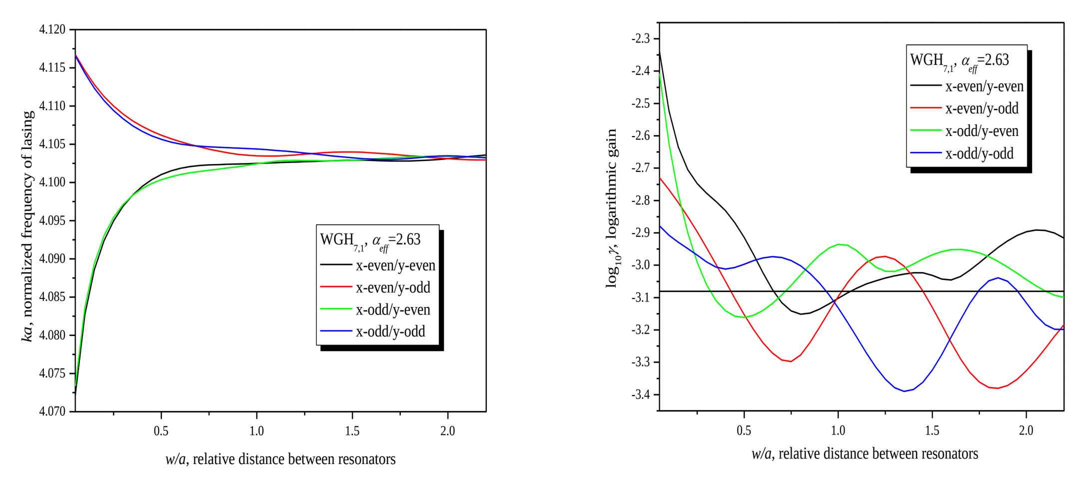




Classes of field symmetry

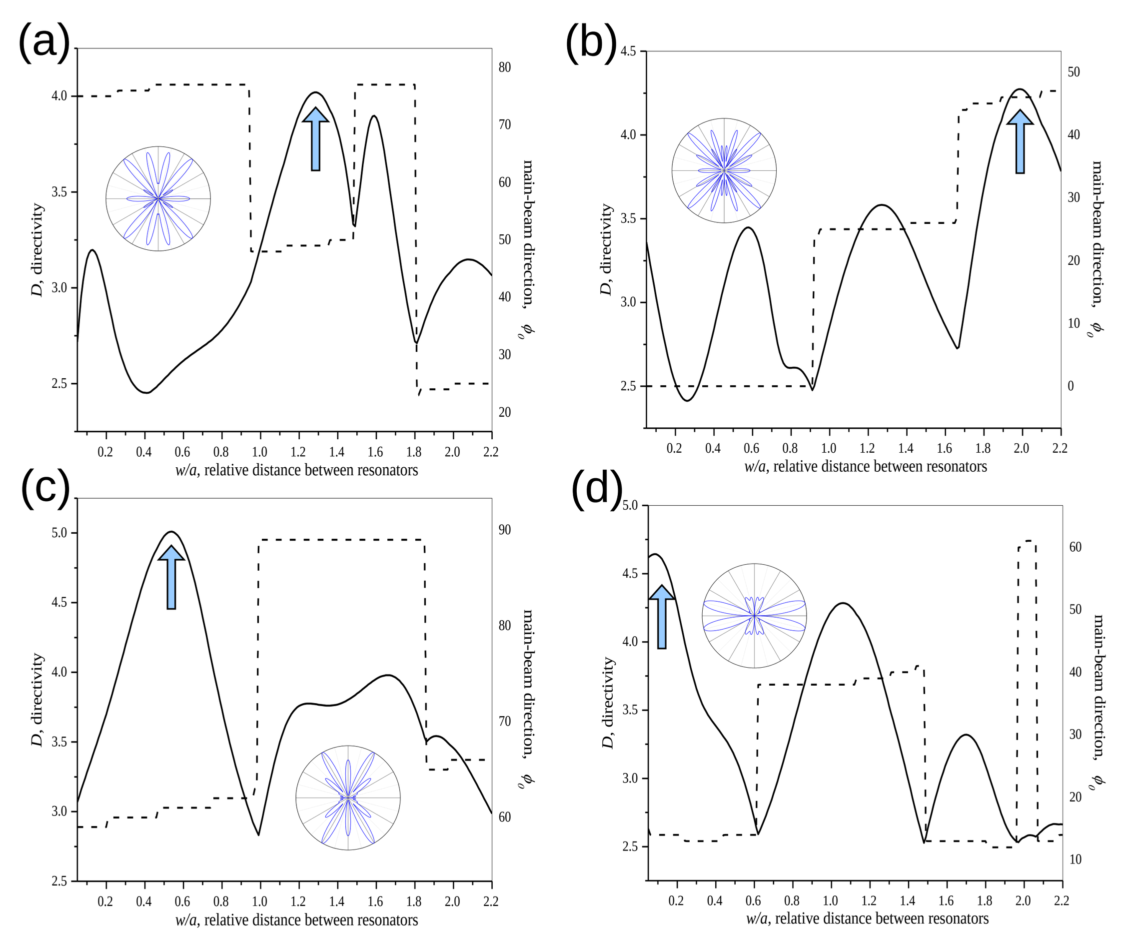



*x-even/y-even (EE)*, (b) *x-odd/y-even (OE)*,
(c) *x-even/y-odd (EO)*, (d) *x-odd/y-odd (OO)*.

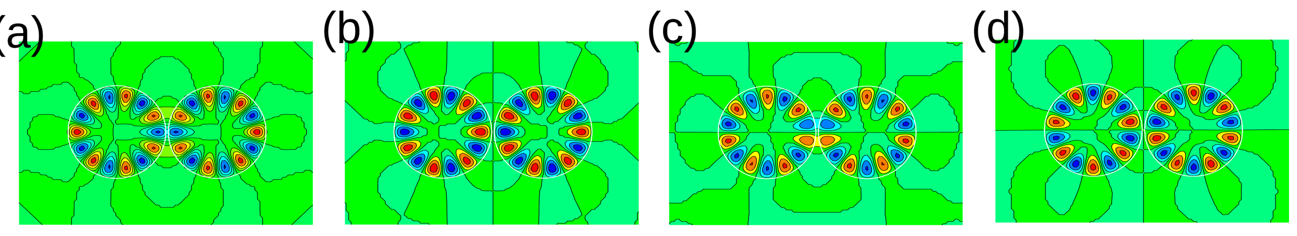
## Effect of coupling




Normalized lasing frequencies and threshold gains for the modes of the families $(H_z)_{7,1}$ in a coupled GaAs disk resonators, $\lambda$ =1.55, $\alpha$=3.374 and $d$=0.1$a$




Dependences of the emission directivity (solid lines) and main-beam radiation angle (dashed lines) on the normalized distance between two resonators, for the $(H_z)_{7,1}$ modes. $\alpha_{eff}$ = 2.63. Mode classes (a) EE, (b) EO, (c) OE, (d) OO. Far-field patterns are shown for the maximum directivities.




Near-field portraits of four $(H_z)_{7,1}$ modes, $\alpha_{eff}$ = 2.63, $w/a$=0.05
(a) *x-even/y-even*, $ka$=4.072, $\gamma$=4.57*10$^{-3}$, (b) *x-even/y-odd*, $ka$=4.117, $\gamma$=1.87*10$^{-3}$,
(c) *x-odd/y-even*, $ka$=4.073, $\gamma$=3.9*10$^{-3}$, (d) *x-odd/y-odd*, $ka$=4.117, $\gamma$=1.32*10$^{-3}$.

## Lasing problem for microdisks

•'Cold cavity with gain' modelling
model associated with purely electromagnetic features of laser as an open cavity with gain

•Quasi 3-D analysis
3-D problem is reduced to 2-D one based on effective index method

•Accurate 2-D analysis
Maxwell's equations + transparent boundary condition + radiation condition at infinity

•Quantification of the frequencies and lasing thresholds
eigenvalue is a pair of real-valued parameters – frequency & threshold material gain

•2-D problem is reduced to an infinite determinant equation with favourable features
The Fredholm second kind nature of matrix provide the convergence of solution of the truncated determinant equation to the exact eigenvalues of infinite matrix

•Two parametric secant-type iterative method is used for calculation of eigenvalues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