Intracellular microlasers

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Title 1–20	Cited by	Year
High-speed optical frequency-domain imaging S Yun, G Tearney, J de Boer, N Iftimia, B Bouma Optics Express 11 (22), 2953-2963	863	2003
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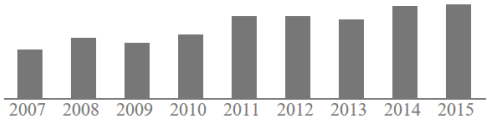
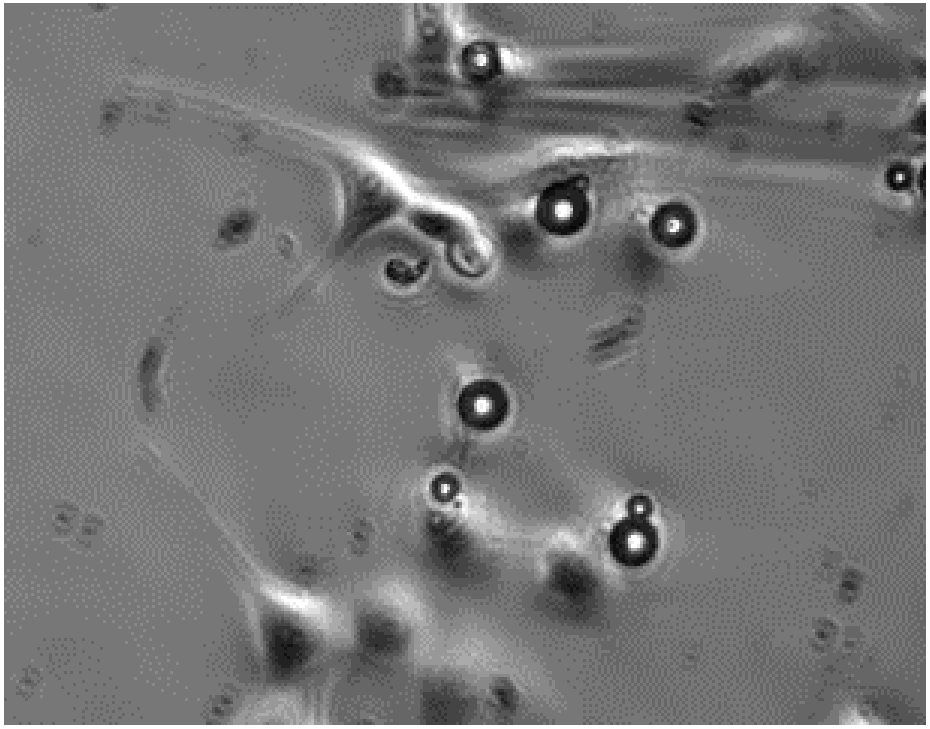


Introduction

- Luminescent probes (dyes, QDs, bioluminescent molecules…) are indispensable tools in cell biology and medical sciences.
- Broad emission spectra limit the number of simultaneously usable probes.
- Optical resonances and stimulated emission allow spectral narrowing.
- Cellular lasers with external cavities demonstrated by the authors and others.
- In this paper, effective approaches to generate stand-alone cell lasers based on intracellular whispering-gallery mode (WGM) resonator.

Soft microresonator (1/2) – Injecting oil into the cells



- Dye-mixed fluid injected into the cells.
- Cytoplasmic internal stress $\Delta\sigma = 500\mathrm{pN/m^2}$ with $20\mathrm{pN/m^2}$ sensitivity measured.
- Dynamic variations of the cellular stress in live and dead cells revealed by time-lapse traces of the output spectra.

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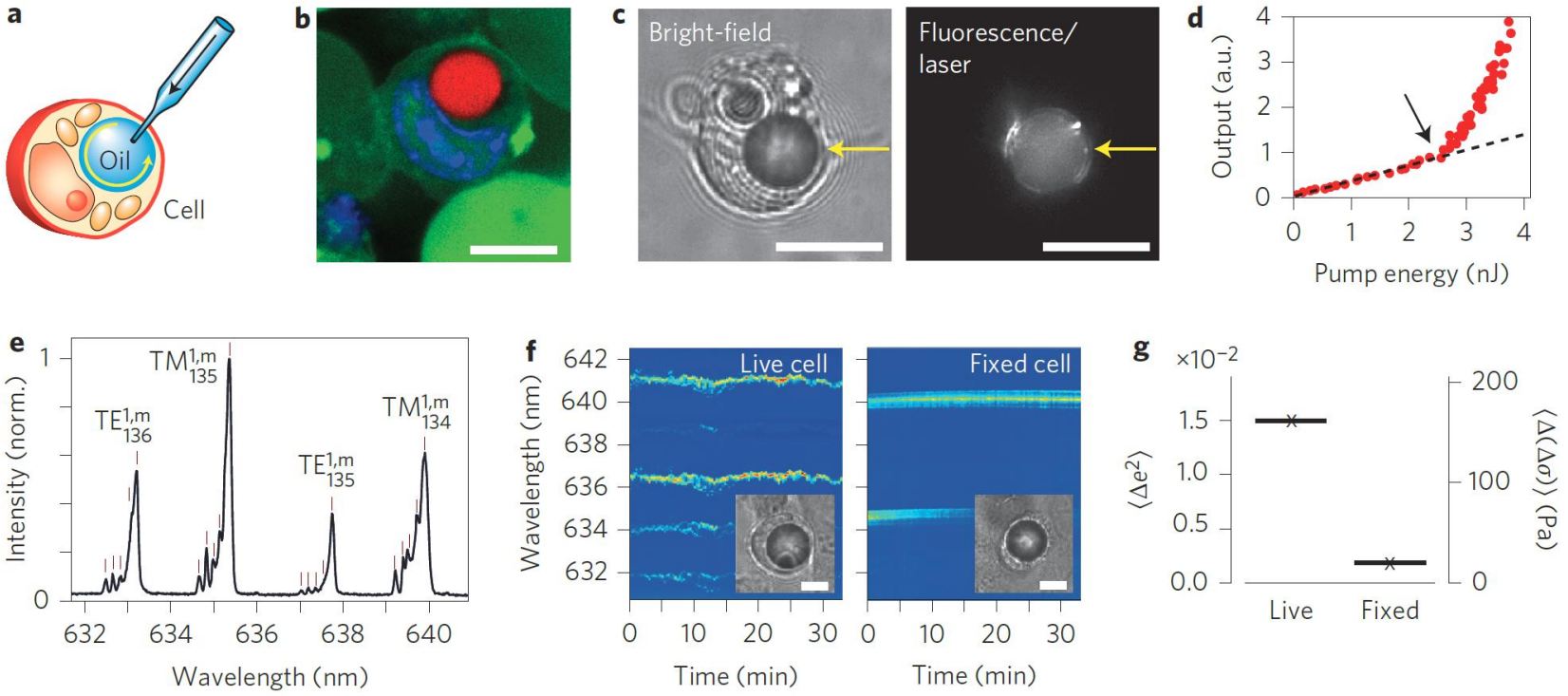

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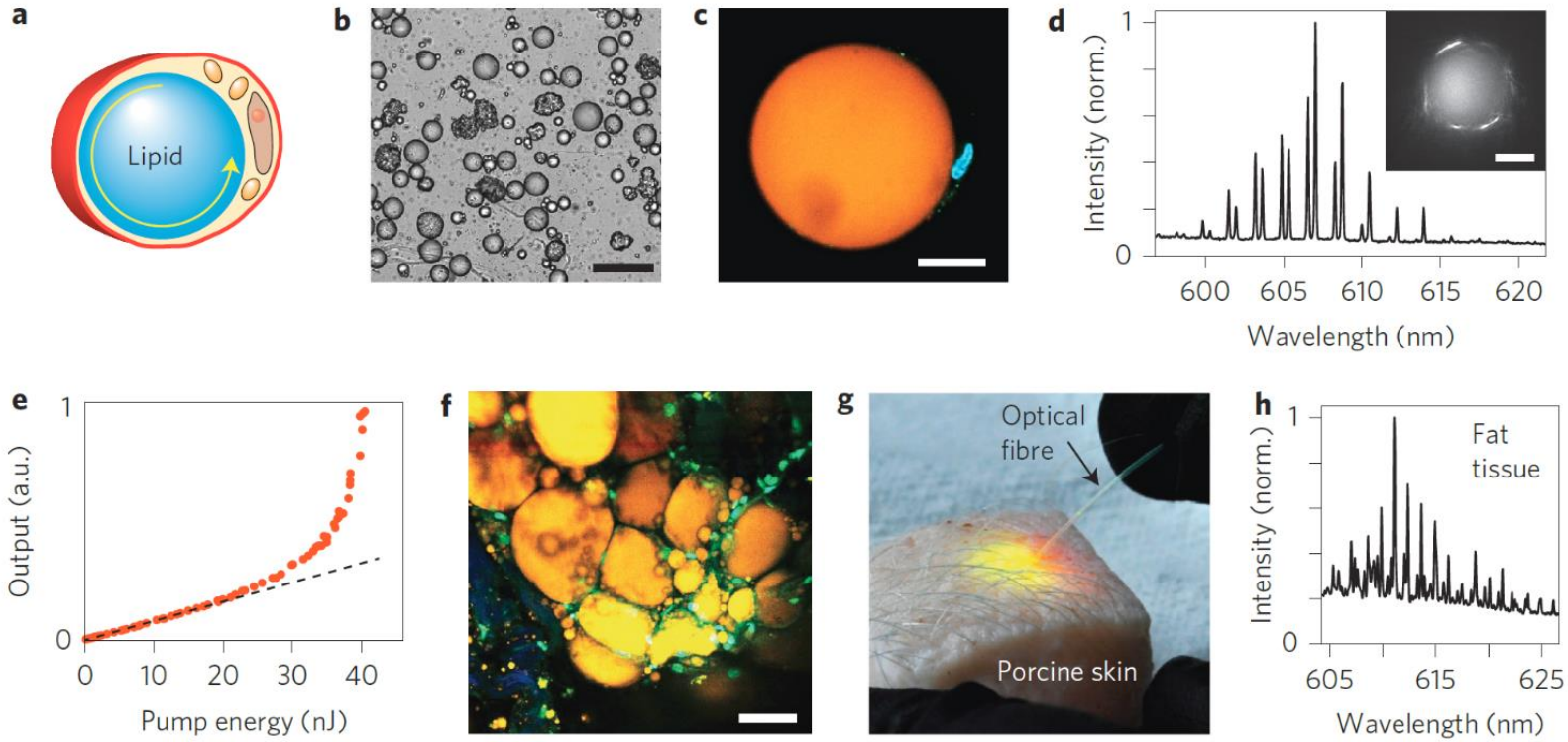
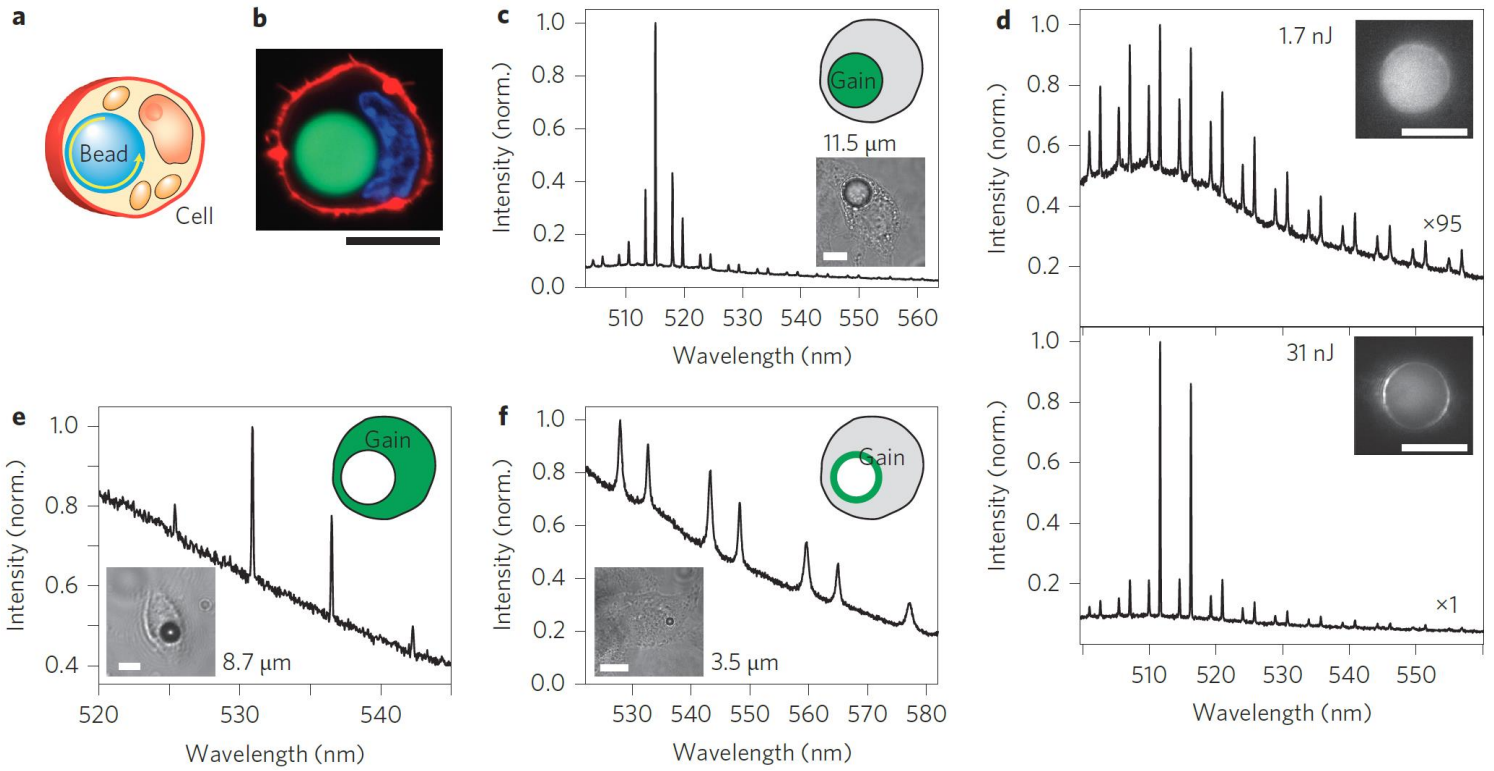
Soft microresonator (2/2) – Natural lipid droplets



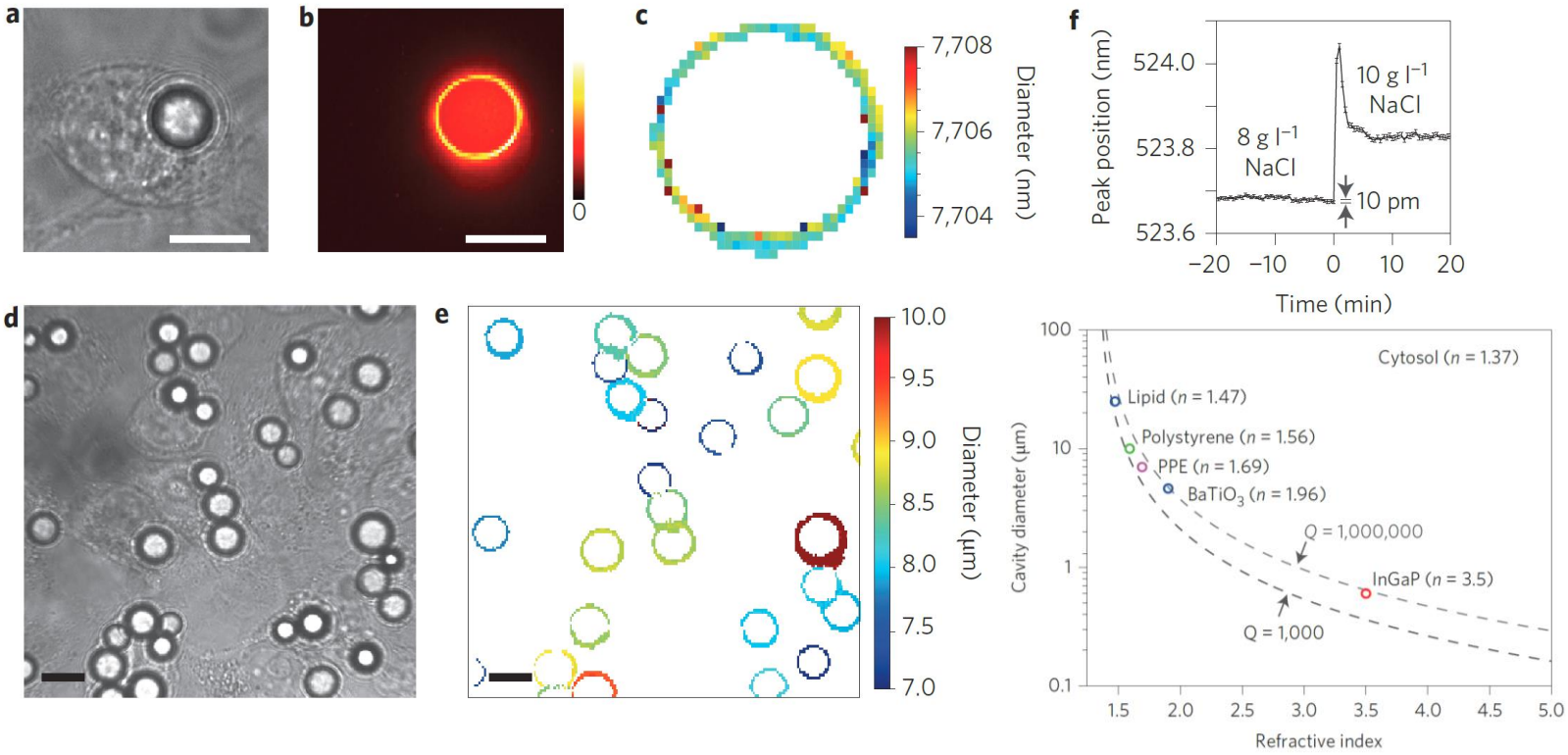
- Incubated adipocytes with a lipophilic fluorescent dye
- Extracted adipocyte contain a single lipid droplet with nearly perfect spherical shape.
- Excited adipocytes in fat showed lasing.

Hard microresonator – Phagocytized polystyrene beads



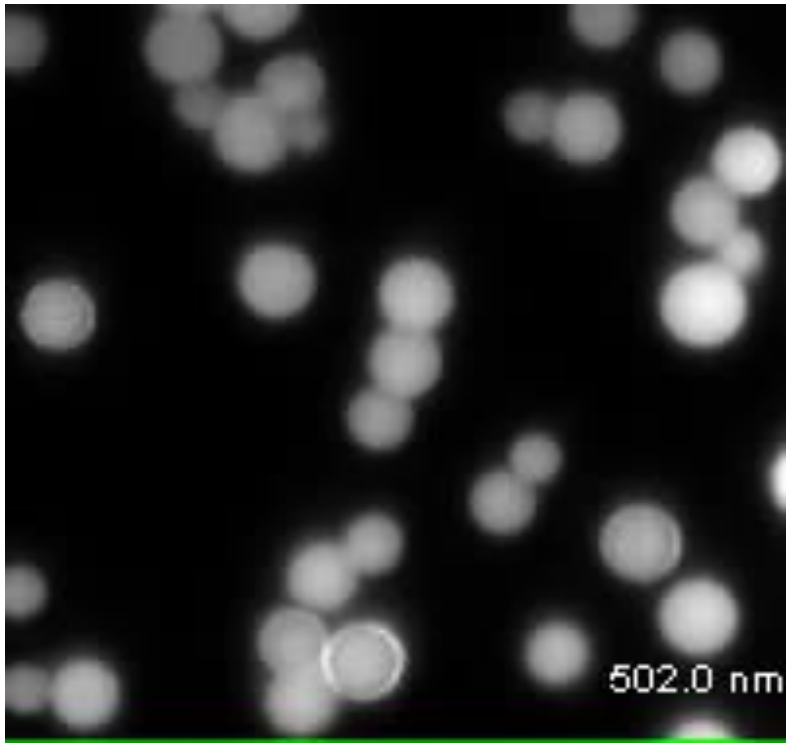
- Polystyrene beads are internalized into HeLa cells by endocytosis.
- Dye-embedded beads, gain-doped cytoplasm, dye-coated beads tested.

Applications



- Effective bead diameter is calculated by fitting the spectra with WGM theory, exhibiting $50\mathrm{pm}$ precision.
- Applied to tag individual cells and 2,000 individual cells distinguished.
- Using three beads per cell and five different dyes with non-overlapping spectra, tagging 2×10^{11} individual cells possible.

Applications



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Summary

- Standalone cell lasers demonstrated by using intracellular WGM microresonators.
- The laser spectra from oil droplets charted cytoplasmic internal stress and its dynamic fluctuations.
- WGM within phagocytized beads of different sizes enabled individual tagging of thousands of cells, in principle, even much larger number possible.