Probing of amyloid structure – microscopy and nanoparticles

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1) $I_{(\alpha)}$

2) $I_{X(\alpha)}$, $I_{Y(\alpha)}$
In our work we present two aspects of amyloid studies:

1) Two-photon microscopy with polarization analysis of **amyloid superstructures**

2) Gold plasmonic nanoparticles self-assembly due to the electrostatic interaction with **amyloid fibrils**

**AMYLOIDS**

Agregates formed from proteins, marked by a characteristic $\beta$-sheet organization with an $\sim 4.7–4.8\text{Å}$ repeat running down the fibril axis

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$L. \text{Gremer et al.}, \text{Science}, 06 \text{ Oct 2017, 358, 6359, pp. 116-119}$
Simultaneous detection of $X$ and $Y$ components of fluorescence enables to reveal information about molecular ordering.

**CAN AMYLOID AUTO-FLUORESCENCE BE USED TO RESOLVE MOLECULAR ORDERING?**

Data fitting model:
Polarization of excitation light (Ex) and emission (Em) are denoted with white arrows.

\( \psi \) - the emission dipole of the dye

\( \Delta \psi \) - aberrations of \( \psi \) due to the molecular rotations

\( \phi \) - rotation of the protofilaments (and fibril) on the XY plane

The average relative angle between the long fibril axis and a transition dipole moment was equal to \( \psi = 30^\circ \) and \( \psi = 29^\circ \) for Thioflavin-T stained samples and autofluorescence, respectively, with \( \Delta \psi \) in both cases equal \( 0^\circ \).
Gold plasmonic nanoparticles self-assembly due to the interactions with amyloid fibrils
We show for the first time that **two-photon excited autofluorescence (2PAF)** of amyloids is highly polarized and distributed within ~30° around the long axis of the fibrils.

Comparison with polarization analysis of two-photon excited fluorescence of ThT bound to similar fibrils shows the same conical distribution of fluorophores.

We show that **gold plasmonic nanoparticles self-assembly on amyloid fibrils and chiro-optical properties are induced**. Our methodology allows for preparation of plasmonic systems in protein-directed and controlled manner.

The presented results provide new methods to probe amyloids organization.

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