



Universiteit  
Leiden  
The Netherlands

## Towards in-cell structural study of light-harvesting complexes : an investigation with MAS-NMR

Azadi Chegeni, F.

### Citation

Azadi Chegeni, F. (2019, March 12). *Towards in-cell structural study of light-harvesting complexes : an investigation with MAS-NMR*. Retrieved from <https://hdl.handle.net/1887/69726>

Version: Not Applicable (or Unknown)

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/69726>

**Note:** To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/69726> holds various files of this Leiden University dissertation.

**Author:** Azadi Chegeni, F.

**Title:** Towards in-cell structural study of light-harvesting complexes : an investigation with MAS-NMR

**Issue Date:** 2019-03-12

# Towards *in-cell* structural study of light-harvesting complexes

An investigation with MAS-NMR

Fatemeh Azadi Chegeni

**ISBN:** 978-94-6380-239-0

**Printed by:** Proefschrift Maken || [www.proefschriftmaken.nl](http://www.proefschriftmaken.nl)

Cover designed by Fatemeh Azadi Chegeni

This research was financed by Leiden University, and a CW-VIDI grant of the Netherlands Organization of Scientific Research (NWO) under grant nr. 723.012.103 (granted to Anjali Pandit). The use of ultrahigh-field Nuclear Magnetic Resonance facility was sponsored by uNMR-NL, an NWO-funded National Roadmap Large-Scale Facility of the Netherlands (grant number: 184.032.207).

# **Towards *in-cell* structural study of light-harvesting complexes**

**An investigation with MAS-NMR**

## **PROEFSCHRIFT**

Ter verkrijging van  
de graad van Doctor aan de Universiteit Leiden,  
op gezag van de Rector Magnificus Prof. mr. C. J. J. M. Stolker,  
volgens besluit van het College voor Promoties te  
verdedigen op dinsdag 12 maart 2019  
klokke 13:45 uur

door

**Fatemeh Azadi Chegeni**  
**Geboren te Khorram Abad, Iran**

## **Promotiecommissie**

---

Promotor: Prof. dr. H. J. M. de Groot  
Co-promotor: Dr. Anjali Pandit

Overige leden: Prof. dr. H. Overkleeft  
Prof. dr. H. Kirchhoff  
Prof. dr. M. Baldus  
Prof. dr. A. Matysik  
Prof. dr. M. van der Stelt

FOR MY PARENTS



# Table of contents

---

## Abbreviations

<b>Chapter 1</b>	Introduction & Methodological background	<b>1</b>
<b>Chapter 2</b>	Protein & lipid dynamics in photosynthetic thylakoid membranes investigated by in-situ NMR	<b>23</b>
<b>Chapter 3</b>	Conformational dynamics of photosynthetic light-harvesting complex II in native thylakoid membranes	<b>49</b>
<b>Chapter 4</b>	Conformational dynamics of zeaxanthin-binding LHCII in a lipid membrane	<b>77</b>
<b>Chapter 5</b>	In-vivo NMR as a tool for probing molecular structure and dynamics in intact <i>Chlamydomonas reinhardtii</i> cells	<b>95</b>
<b>Chapter 6</b>	General Discussion and future prospects	<b>115</b>
<b>Appendices</b>	Summary	<b>122</b>
	Samenvatting	<b>125</b>
	Curriculum vitae	<b>128</b>
	Publications	<b>129</b>
	Acknowledgement	<b>130</b>

## Abbreviations

---

Car	Carotenoid
Chl <i>a</i>	Chlorophyll <i>a</i>
Chl <i>b</i>	Chlorophyll <i>b</i>
CP	Cross polarization
<i>Cr.</i>	<i>Chlamydomonas reinhardtii</i>
CSA	Chemical Shielding Anisotropy
Cyt b <sub>6</sub> f	Cytochrome- <i>b</i> <sub>6</sub> <i>f</i> complex
DGDG	DiGalactosylDiacylGlycerol
DGTS	DiacylGlycerylTrimethylhomo-Ser
DP	Direct Polarization
FA	Fatty Acid
INEPT	Insensitive Nuclei Enhanced by Polarization Transfer
LH2	Light Harvesting 2
LHCI	Light Harvesting Complex I
LHCII	Light Harvesting Complex II
MAS	Magic Angle Spinning
MD	Molecular Dynamics
MGDG	MonoGalactosylDiacylGlycerol
Neo	Neoxanthin
NMR	Nuclear Magnetic Resonance
NPQ	Non-Photochemical Quenching
PARIS	Phase-Alternated Recoupling Irradiation Scheme
PE	PhosphatidylEthanolamine
PG	Phosphatidyl-Glycerol
Photo-CIDNP	Photo-Chemical Induced Nuclear Polarization
PQ	Plastoquinone
PQH <sub>2</sub>	Plastoquinol
PSI	Photosystem I
PSII	Photosystem II
SQDG	SulfoQuinovosylDiacylGlycerol
SSNMR	Solid State NMR
TAP	Tris-Acetate Phosphate
TOBSY	TOtal through Bond correlation SpectroscopY
Vio	Violaxanthin
ZE	Zeaxanthin Epoxidase
Zea	Zeaxanthin