Development of Frequency Domain Multidimensional Spectroscopy with Applications in Semiconductor Photophysics

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CMDS

The Wright Group focuses on the development and usage of coherent multidimensional spectroscopy (CMDS). CMDS is a family of related nonlinear spectroscopic experiments.

Why CMDS?

[A BUNCH OF COOL PUBLICATIONS—FOCUSING ON COHERENCE TRANSFER, MECHANISMS ETC] [MORE APPLICATIONS]

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Coherence in Energy Transfer and Photosynthesis

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Analytical

But wait! I'm an *Analytical* Chemist?!
The dream of the Wright Group (if not the current reality) [REASONS FOR ANALYTICAL CHEMISTRY TO BE INTERESTED IN CMDS]

ACCOUNTS
of chemical research

Mixed Frequency-/Time-Domain Coherent Multidimensional Spectroscopy: Research Tool or Potential Analytical Method?

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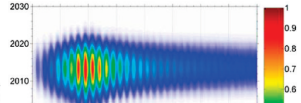
CONSPECTUS

Coherent multidimensional spectroscopy (CMDS) is now the optical analogue of nuclear magnetic resonance (NMR). Just as NMR heteronuclear multiple-quantum coherence (HMQC) methods rely on multiple quantum coherences, achieving widespread application requires that CMDS also excites multiple quantum



Domains of CMDS

CMDS can be collected in two domains:

- time domain
- frequency domain

Time domain

[DESCRIPTION OF TIME DOMAIN]

Frequency domain

[DESCRIPTION OF FREQUENCY DOMAIN]

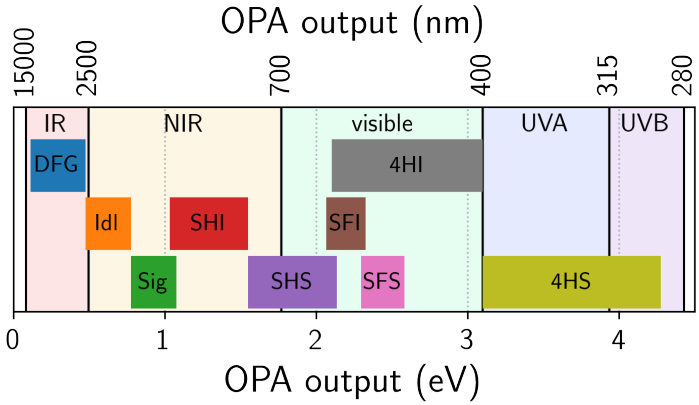
Domains of CMDS

Most experiments are collected in the time domain

- fast
- robust

So... why frequency domain?

Bandwidth


OPA output (nm)
15000
2500
700
400
315
280
IR
NIR
visible
UVA
UVB
DFG
4HI
IdI
SHI
SFI
Sig
SHS
SFS
4HS
0
1
2
3
4
OPA output (eV)

Selection rules

The instrument

[PICTURE OF LASER LAB]

The instrument

Many kinds of component hardware

- monochromators
- delay stages
- filters
- OPAs

$\sim$ 10 settable devices, $\sim$ 25 motors.
Multiple detectors.

Pipeline

What does the “pipeline” of MR-CMDS data acquisition and processing look like in the Wright Group?
How to increase data throughput and quality, while decreasing frustration of experimentalists?

Processing

WrightTools.
Universal file format.
A unique, flexible multidimensional data model.

Acquisition

PyCMDS.
Modular software.

Tuning

MR-CMDS theory

Mixed domain

[FIGURES FROM DAN'S PAPER]