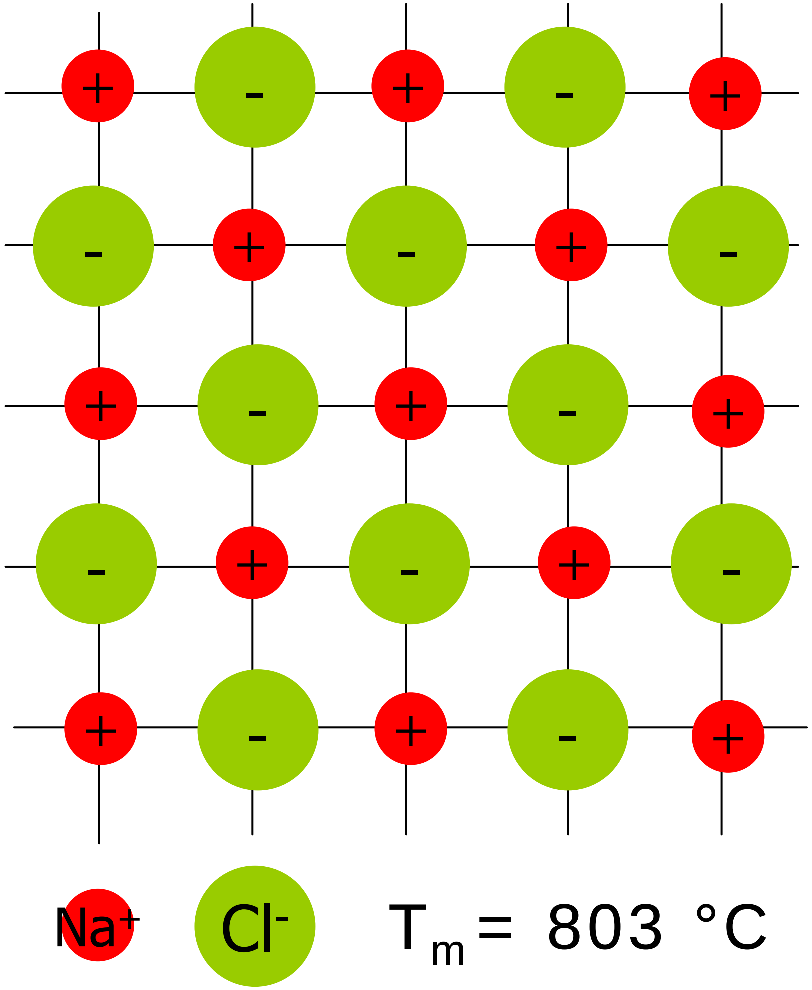
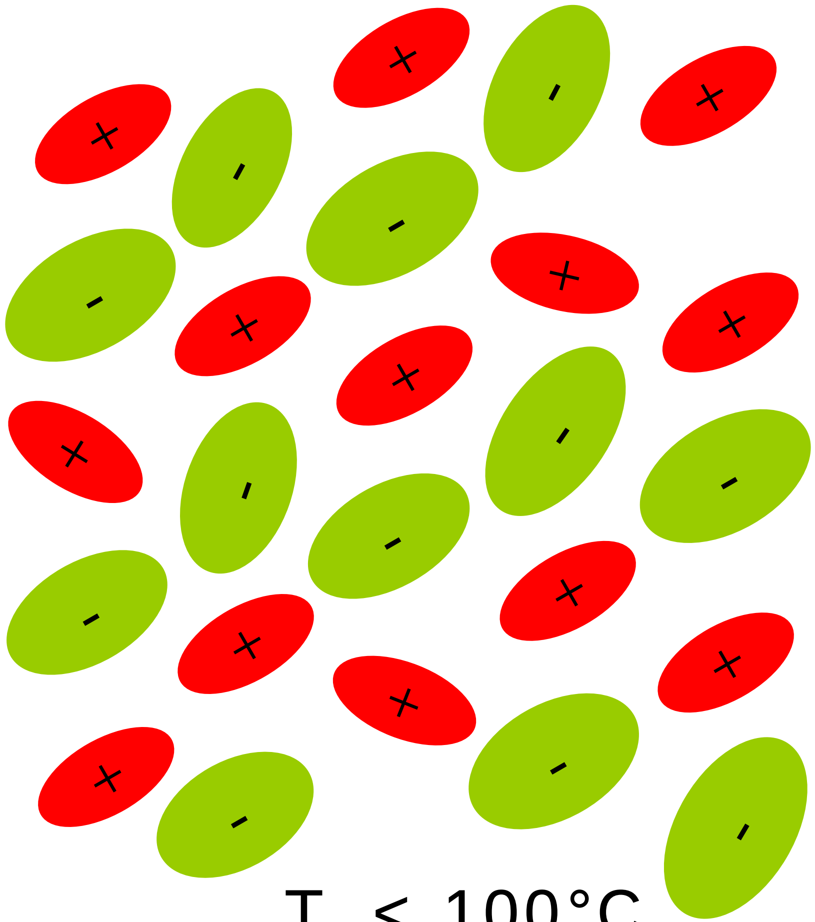
Beispiel 8: Ionische Flüssigkeiten

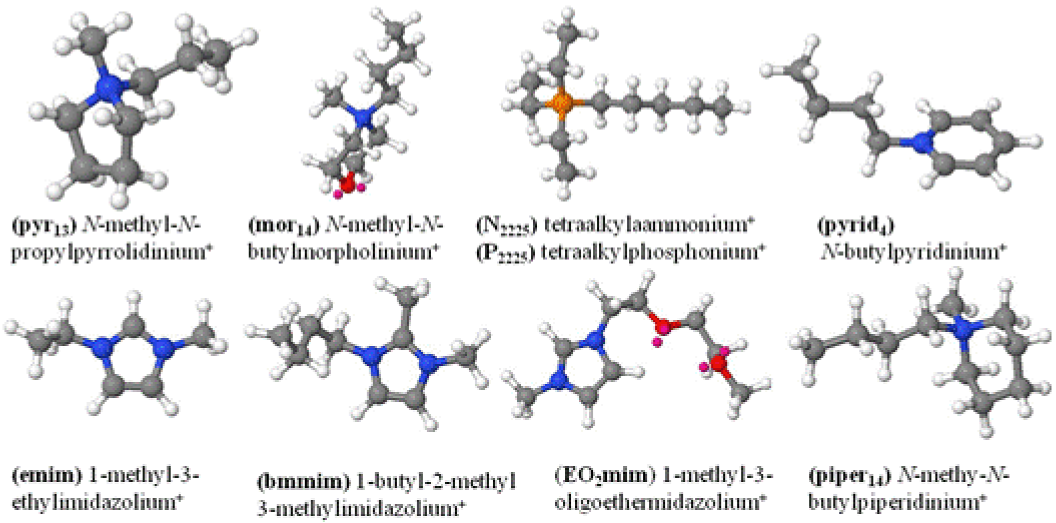


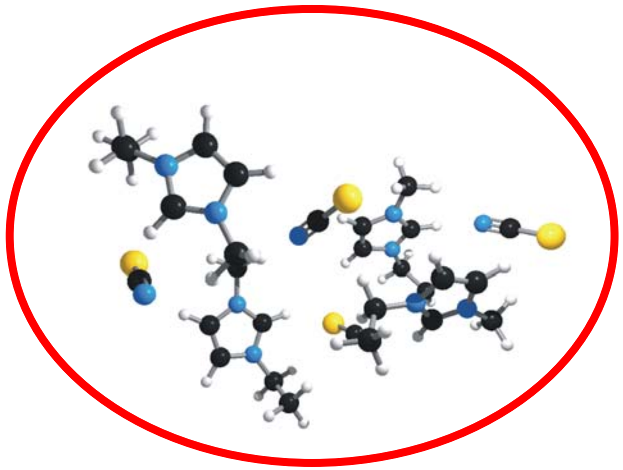
$T_m = 803\ °C$

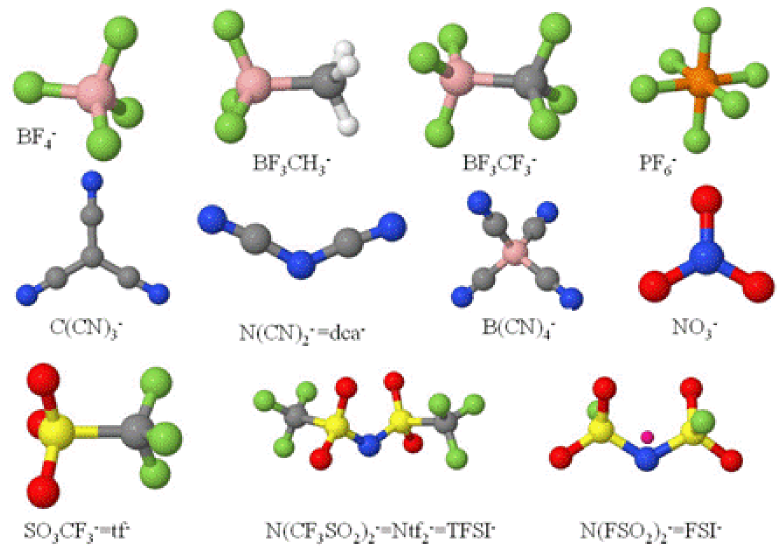


$T_m < 100°C$

Beispiel 8: Ionische Flüssigkeiten



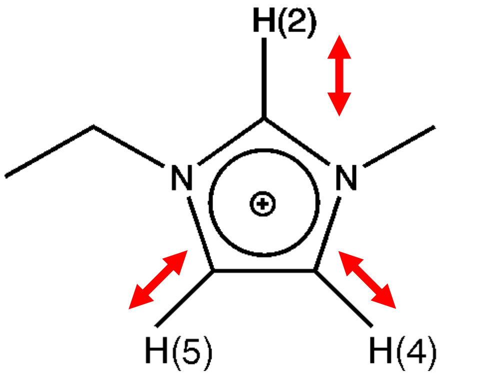




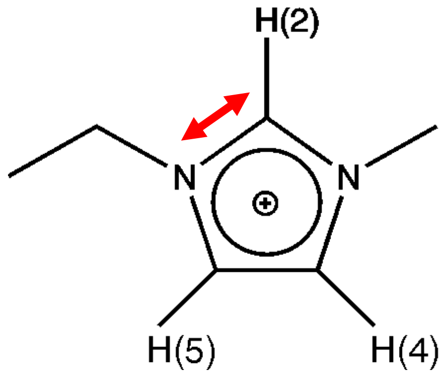
10^{12} Möglichkeiten!

- Schmelzpunkte
- Viskositäten
- Leitfähigkeiten
- Löslichkeiten etc.

Beispiel 8: Mittleres Infrarot



$\nu_s \sim 3000\text{-}3200\ \mathrm{cm}^{-1}$



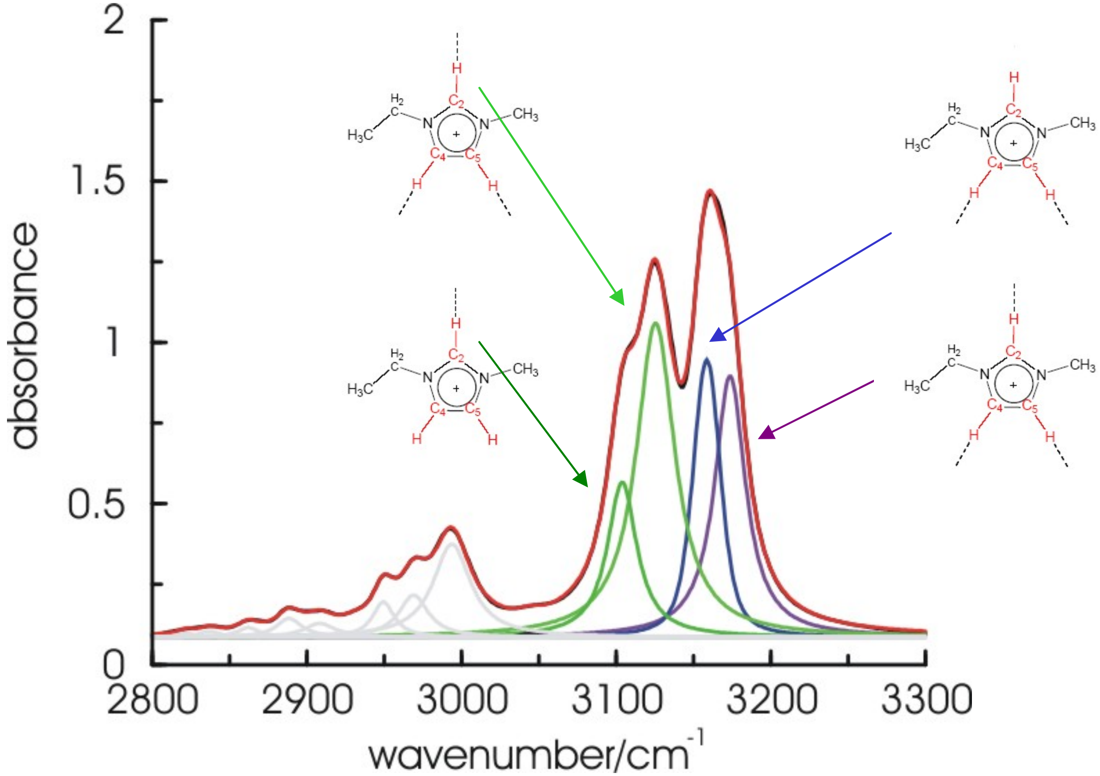
$\nu_s \sim 1550\text{-}1600\ \mathrm{cm}^{-1}$

$$\boxed{\omega = \sqrt{\frac{k}{\mu}}}$$

$$\boxed{\mu = \frac{m_1 m_2}{m_1 + m_2}}$$

Beispiel 8: Mittleres Infrarot

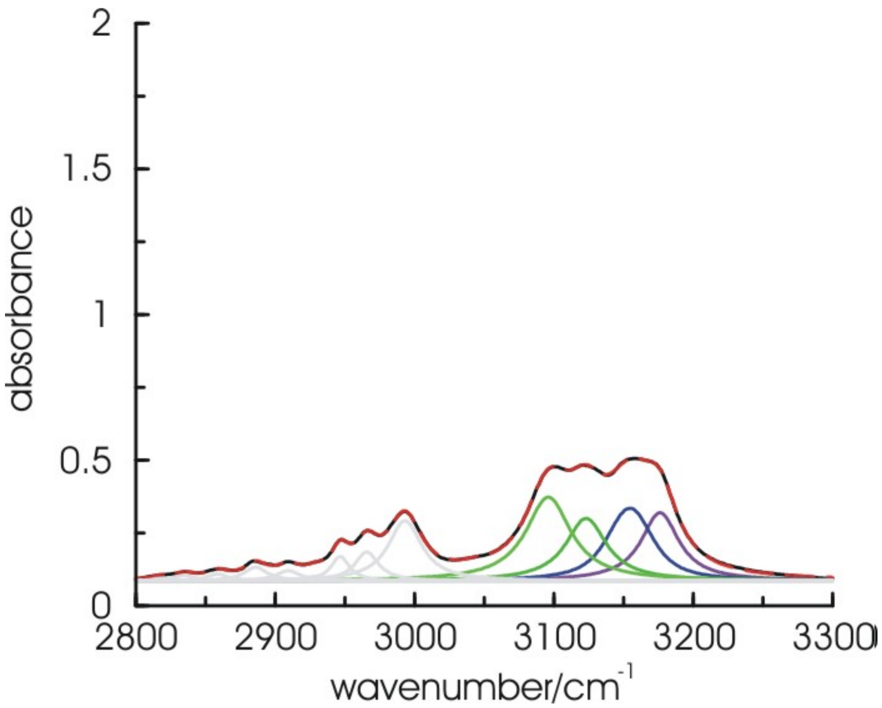
$[C_2mim][NTf_2]$

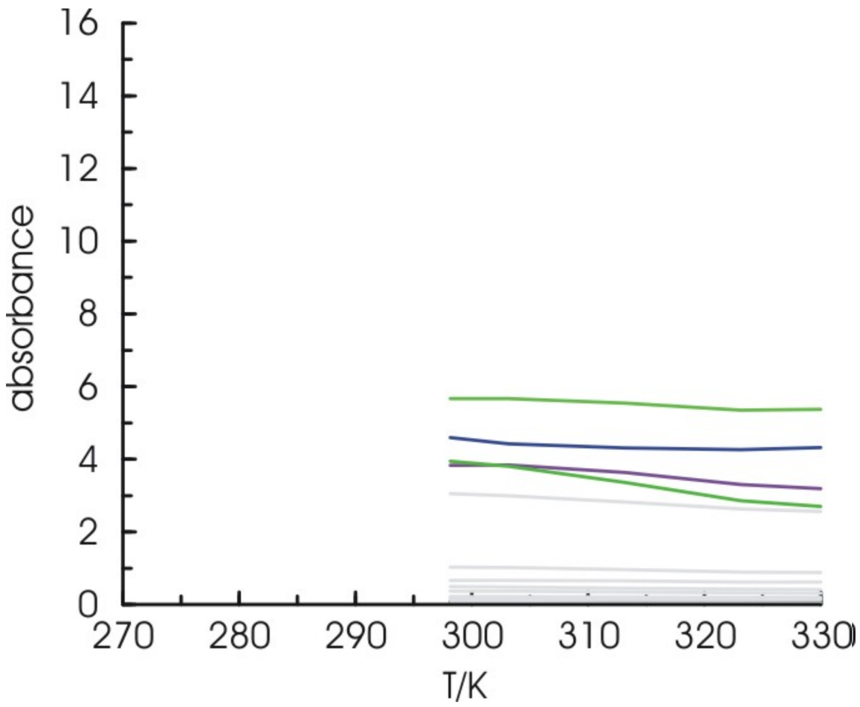


T. Köddermann, C. Wertz, A. Heintz, R. Ludwig. ChemPhysChem, 7 (9): 1944-1949, 2006.

Beispiel 8: Mittleres Infrarot

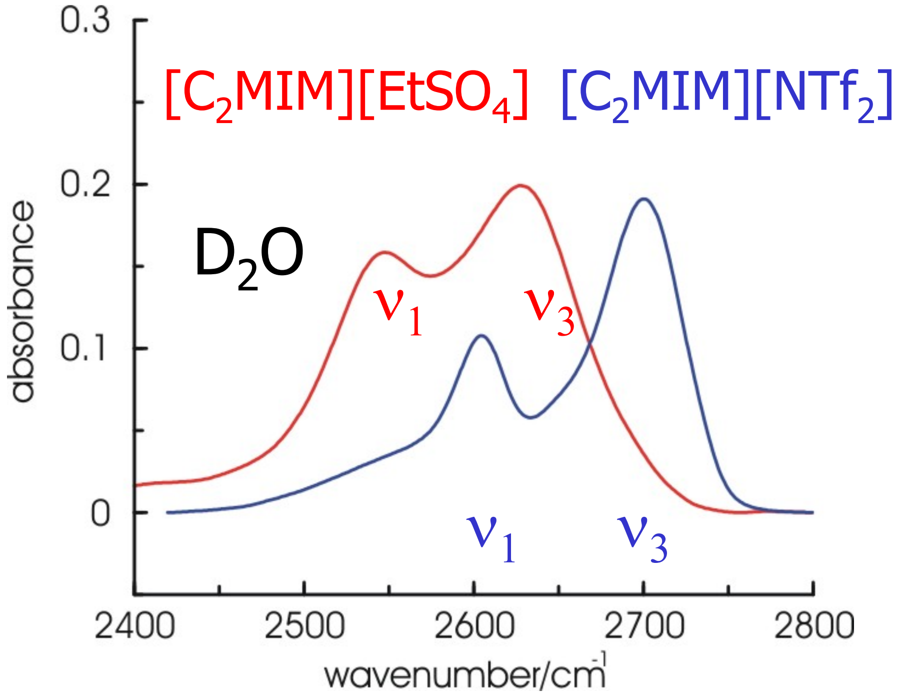
$[C_2mim][NTf_2]$ in chloroform

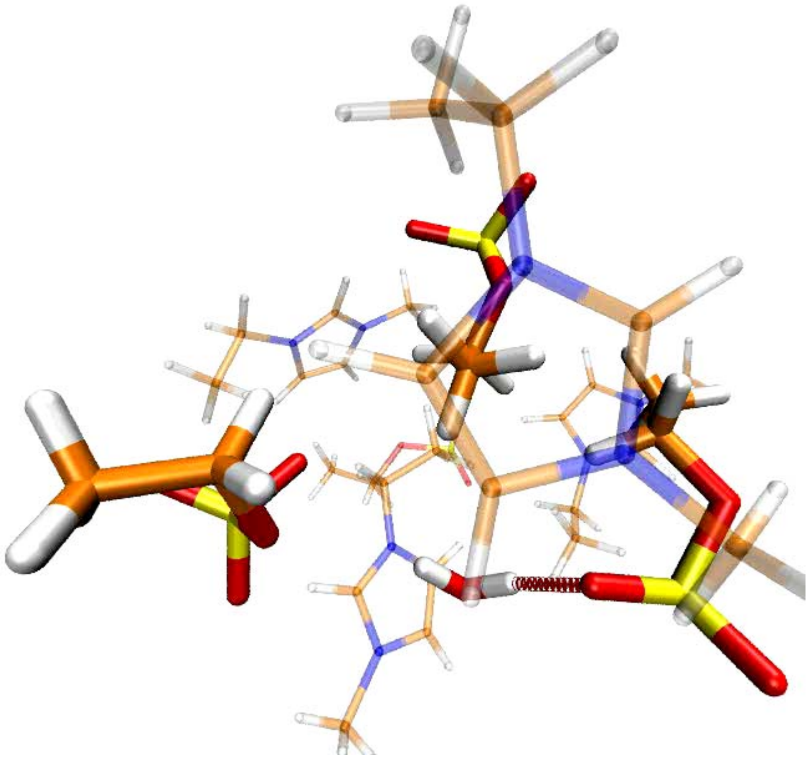




T. Köddermann, C. Wertz, A. Heintz, R. Ludwig. ChemPhysChem, 7 (9): 1944-1949, 2006.

Beispiel 8: Mittleres Infrarot

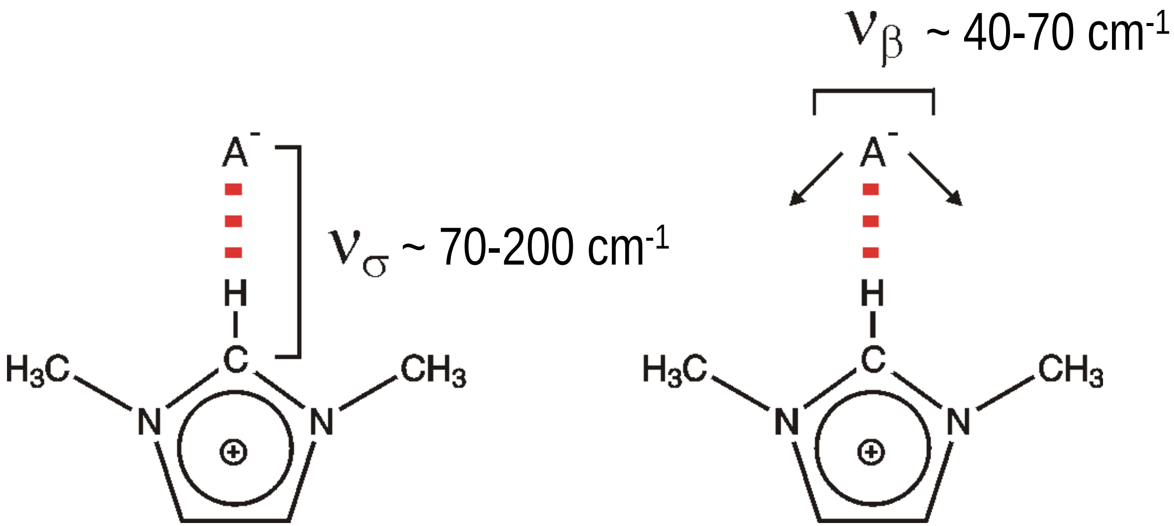




CPMD

T. Köddermann, C. Wertz, A. Heintz, R. Ludwig, Angew. Chem., 2006, 45, 3697-3702.

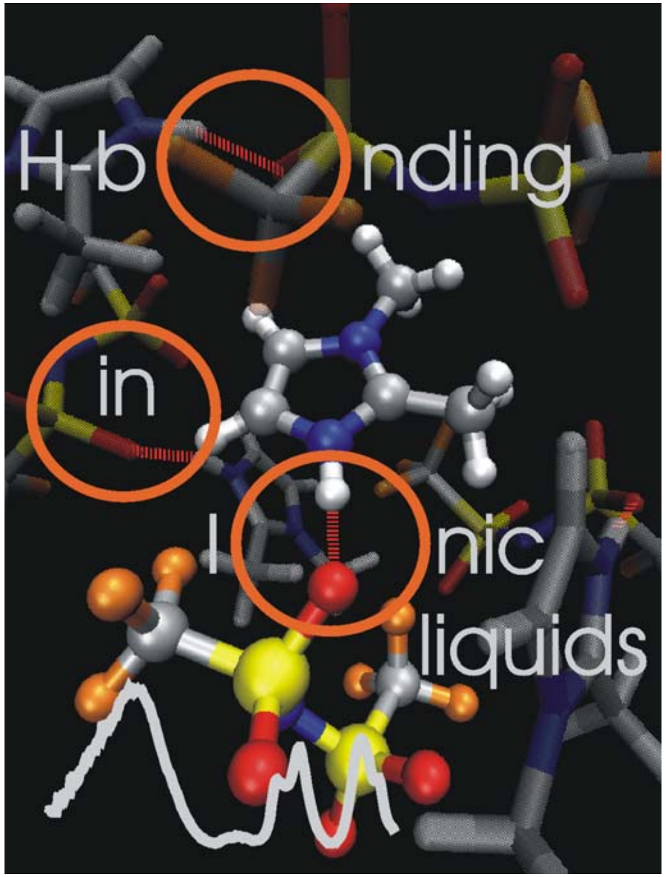
Beispiel 8: Ferninfrarot



$$\omega = \sqrt{\frac{k}{\mu}}$$

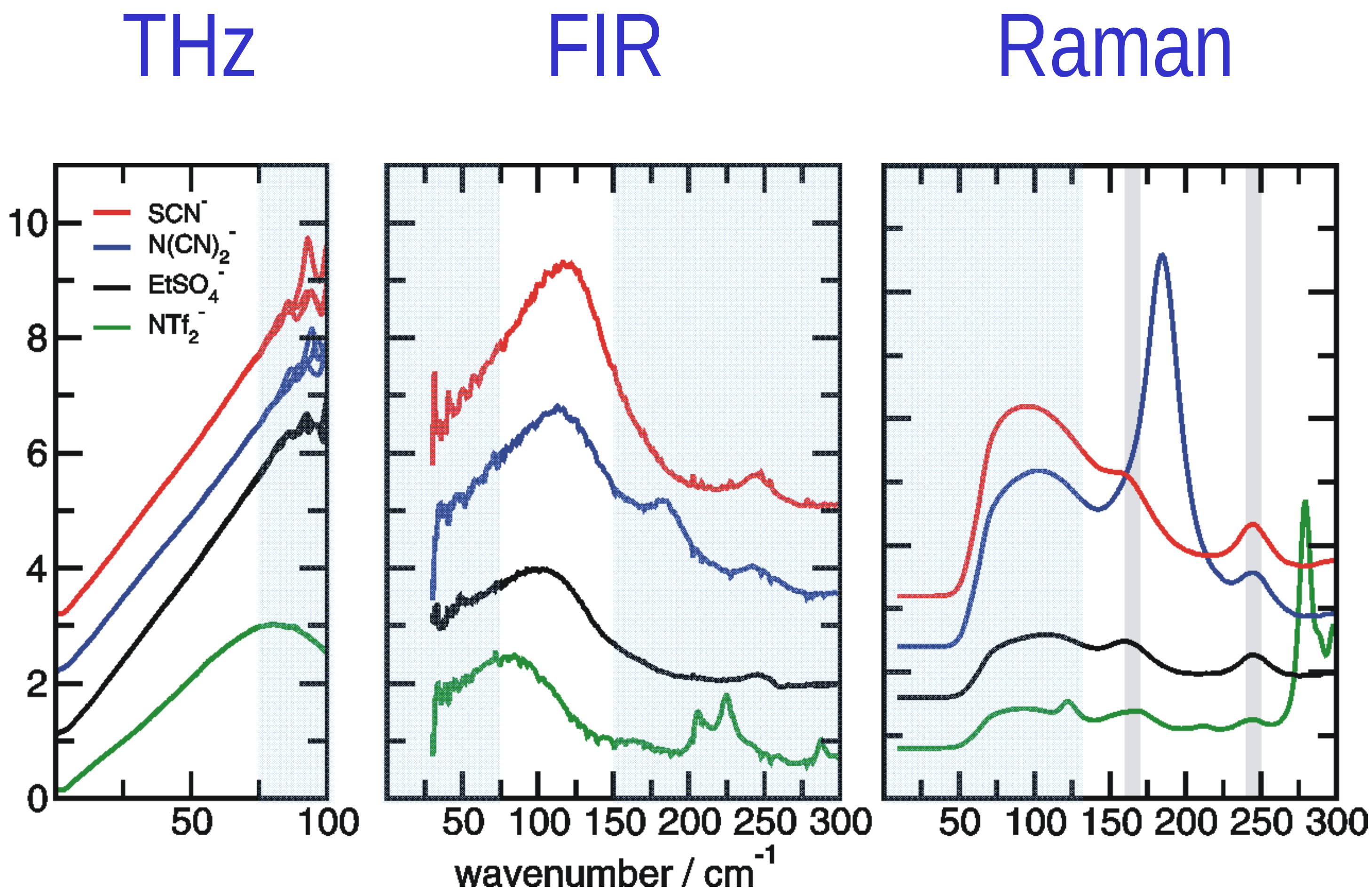
$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

Beispiel 8: Ferninfrarot



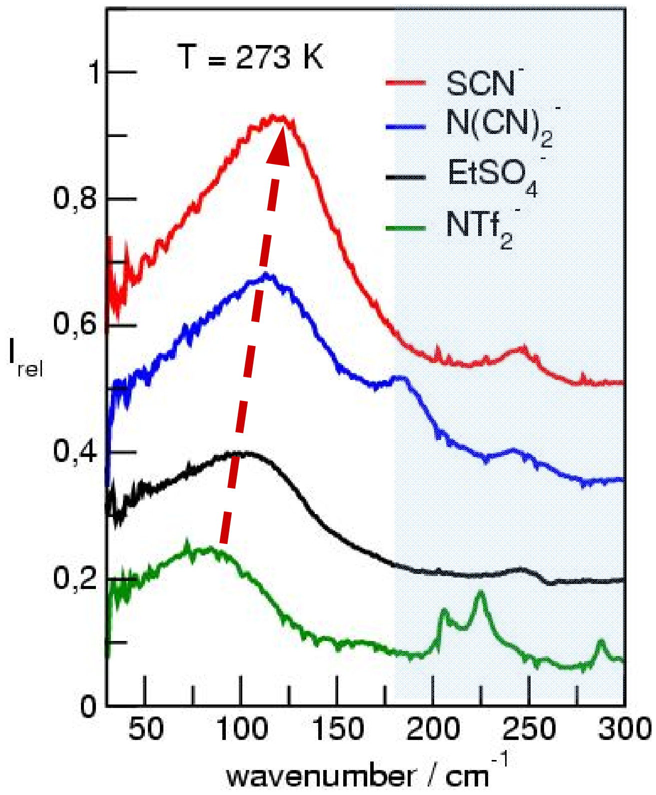
- anion-cation interaction
- Coulomb – H-bonds – dispersion
- influence on properties
- small programme, selected ILs

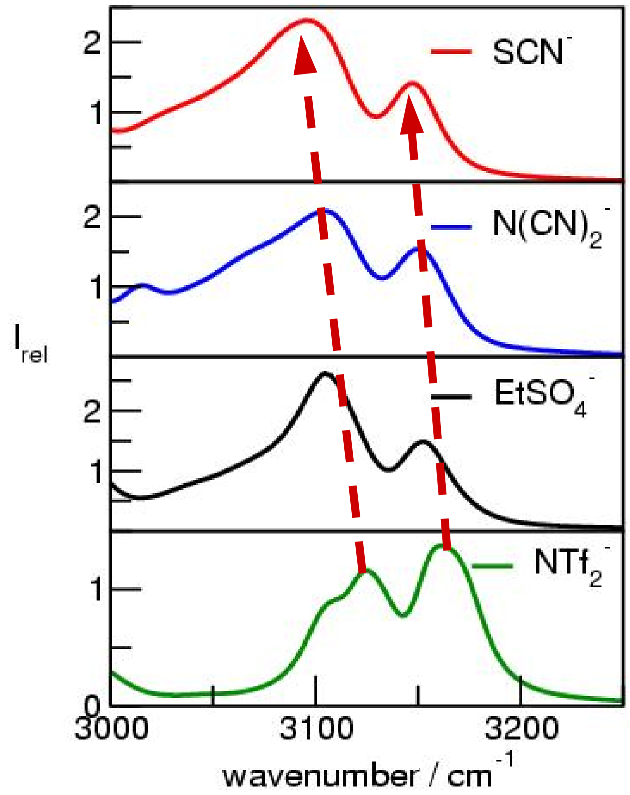
Beispiel 8: Ferninfrarot



K. Fumino, A. Wulf, R. Ludwig, ChemPhysChem, 2009, published online.

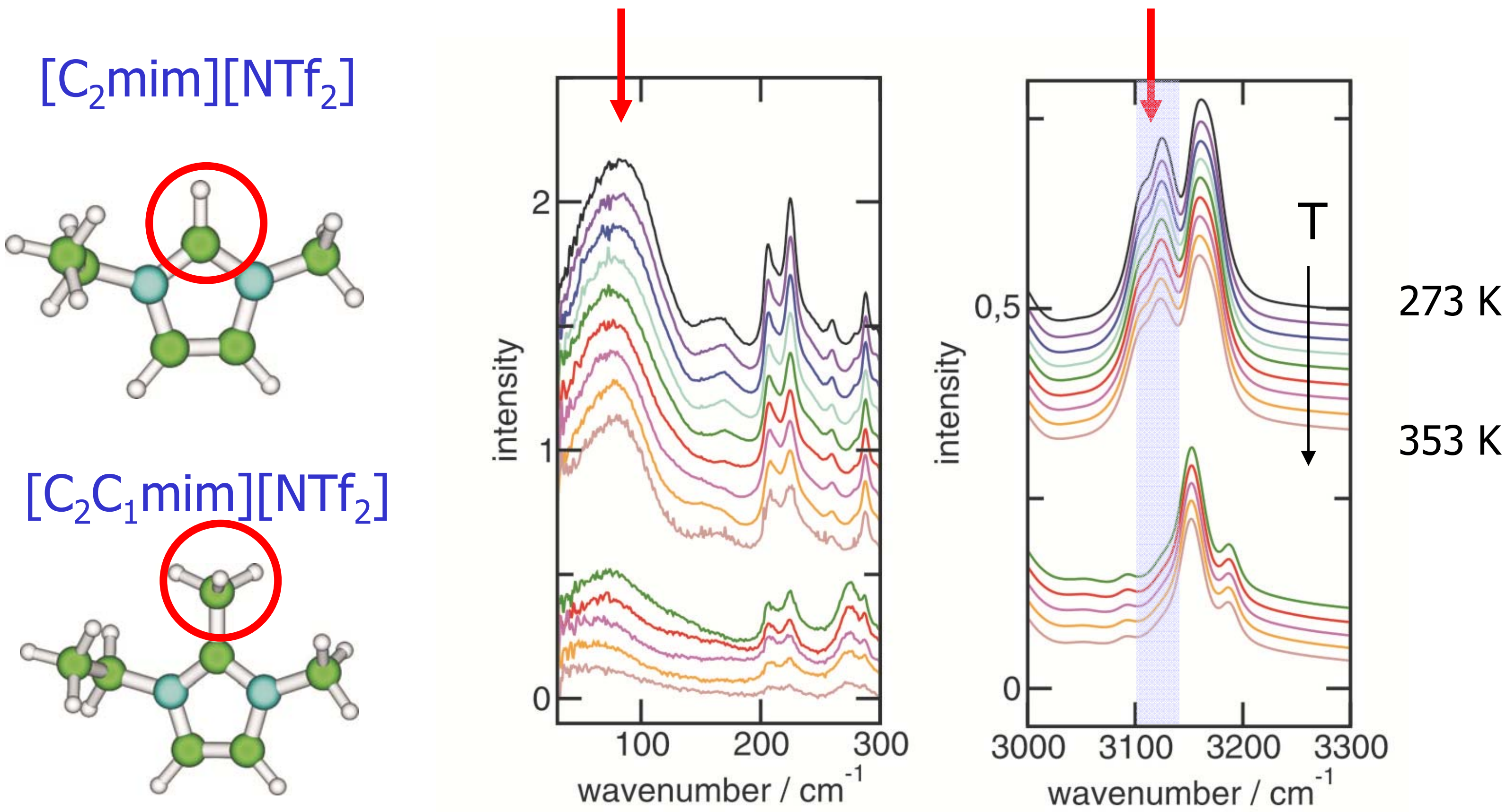
Beispiel 8: Ferninfrarot





K. Fumino, A. Wulf, R. Ludwig, Angew. Chem. Int. Ed., 2008, 47, 3830-3834.

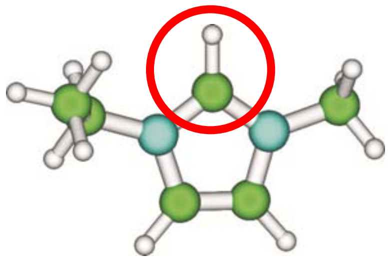
Beispiel 8: Ferninfrarot

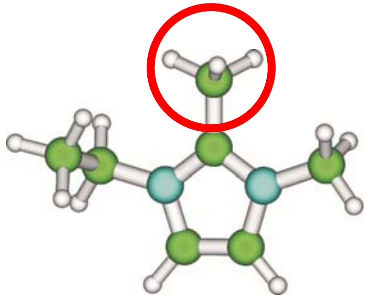


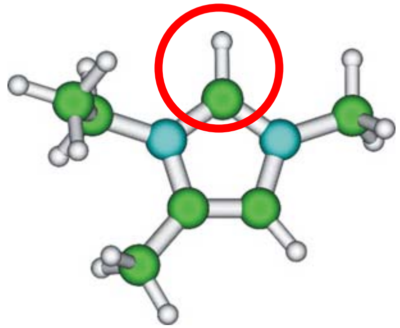
K. Fumino, A. Wulf, R. Ludwig, Angew. Chem. Int. Ed., 2008, 47, 8731-8734.

Beispiel 8: Ferninfrarot

[1-ethyl-3-methyl] [1-ethyl-2,3-methyl] [1-ethyl-3-methyl-5M]



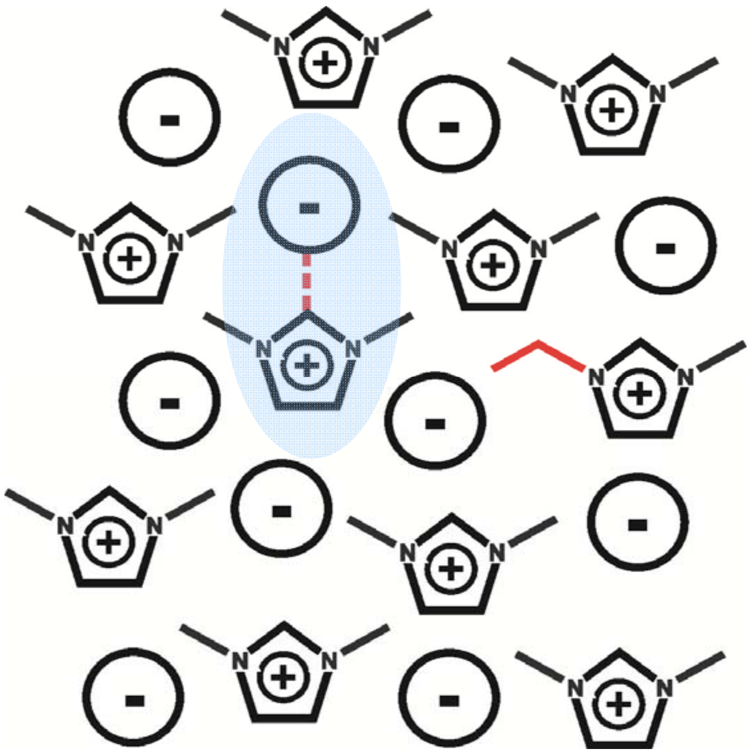


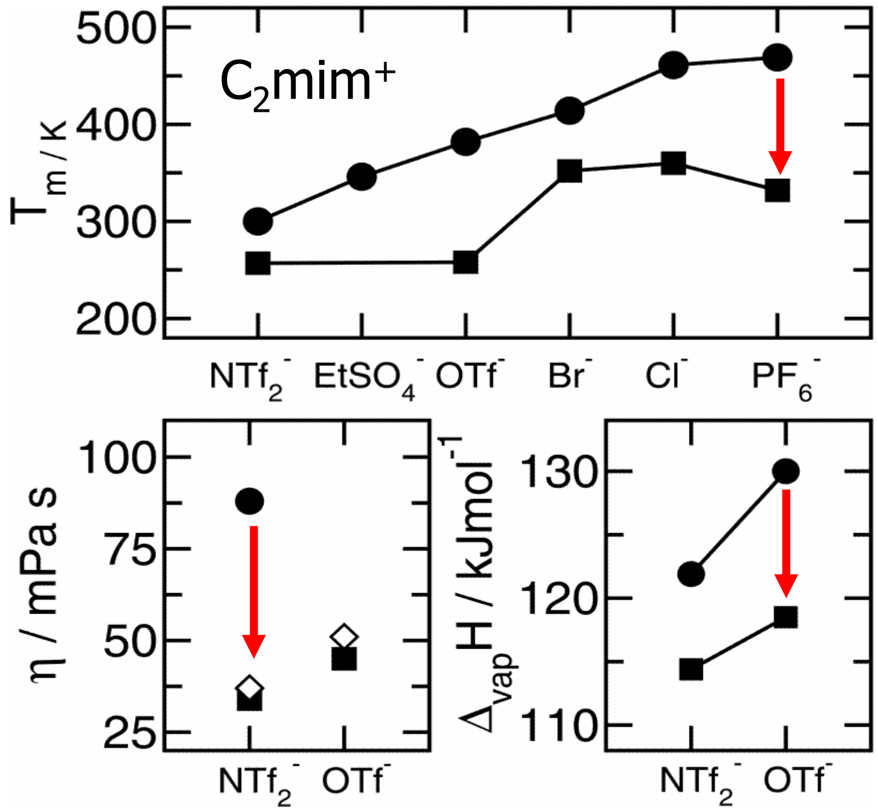


	[1-ethyl-3-methyl]		[1-ethyl-2,3-methyl]	[1-ethyl-3-methyl-5M]
T_m/°C:	-3, -17, -18	→	20, 25, 27	-3
η/mPas:	34, 36, 39	→	88	37

P. Bonhôte, A.-P. Dias, N. Papageorgiou, K. Kalyanasundaram, M. Grätzel, Inorg. Chem. 1996, 35, 1168-1178.

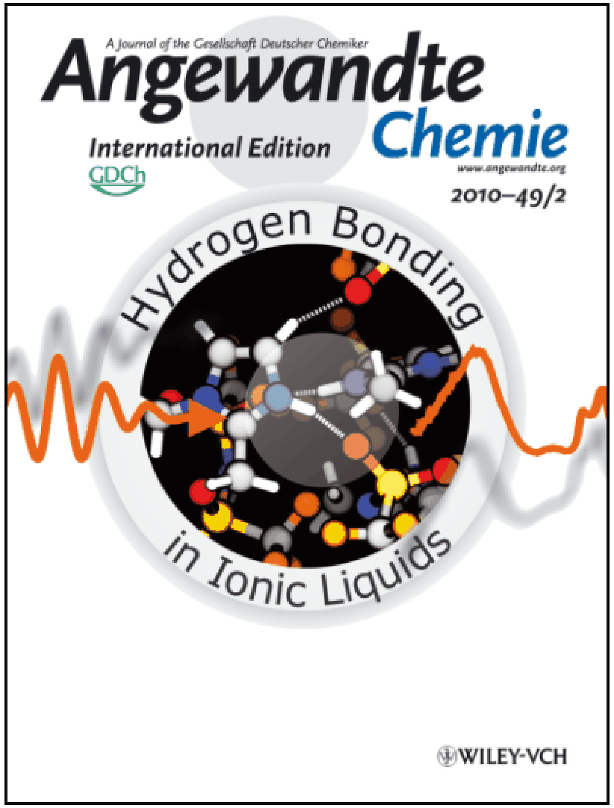
Beispiel 8: Ferninfrarot

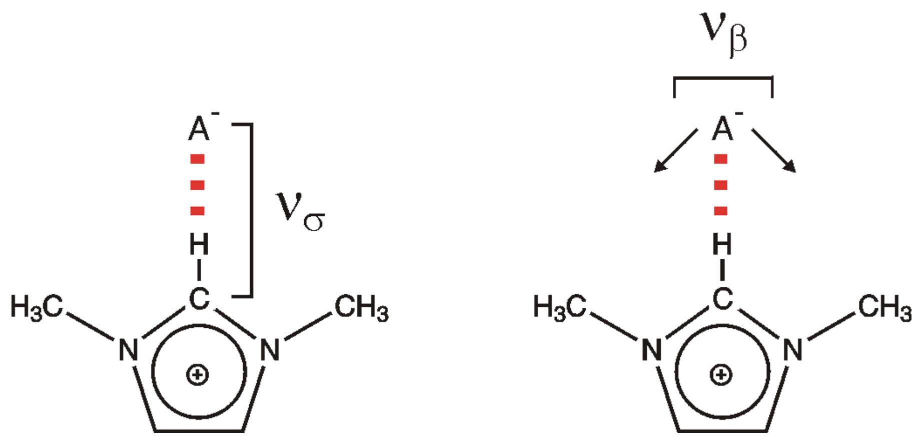




K. Fumino, A. Wulf, R. Ludwig, Angew. Chem. Int. Ed., 2008, 47, 8731-8734.
L. Luo, G. A. Baker, S. Dai, J. Phys. Chem. B, 2008, 112, 10077-10081.

Beispiel 8: Ferninfrarot





Open issues:

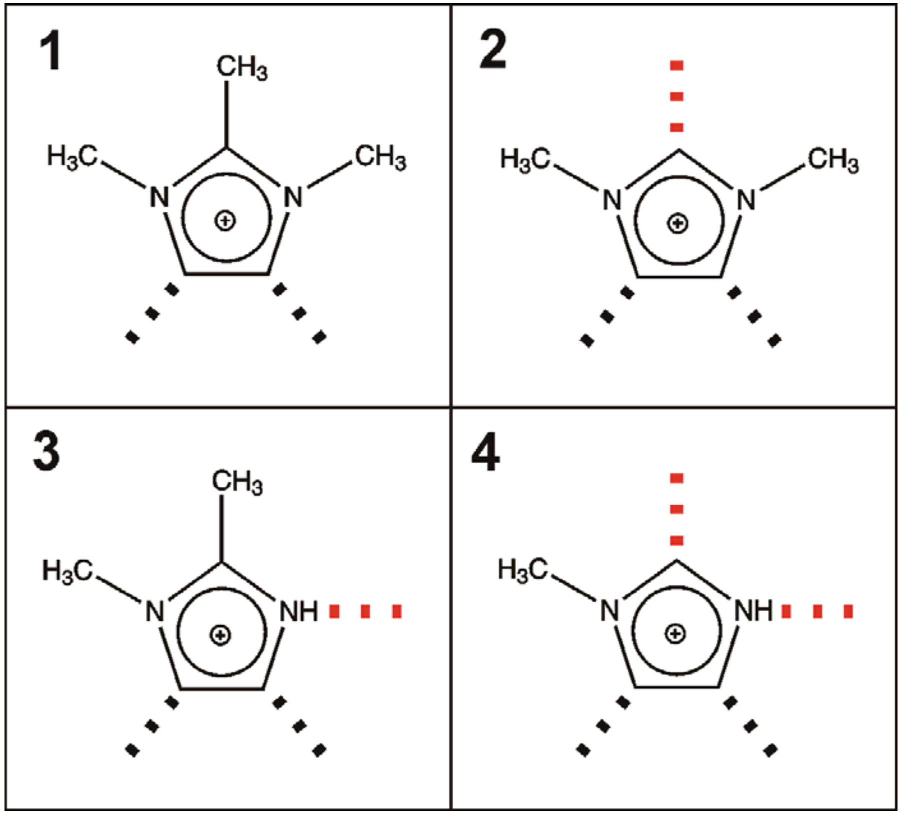
1. k or μ

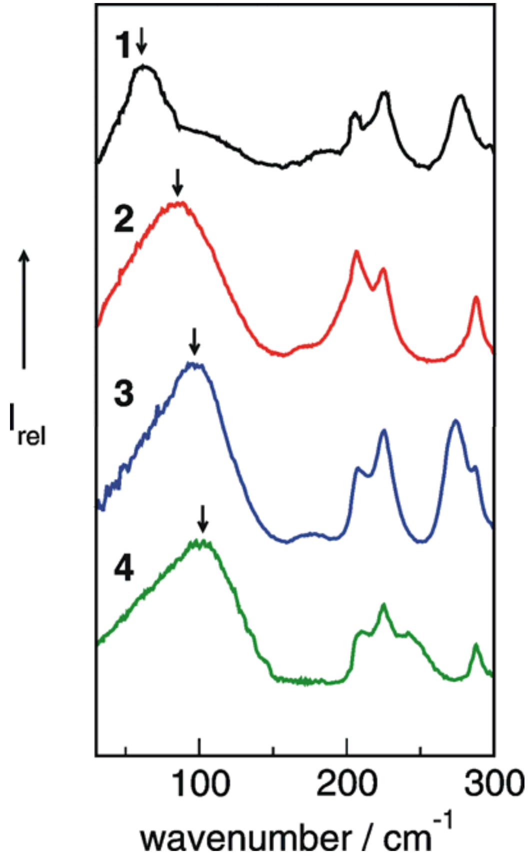
$$\boxed{\omega = \sqrt{\frac{k}{\mu}}}$$

2. local & directional

K. Fumino, A. Wulf, R. Ludwig, Angew. Chem., 2010,49, 449-453.

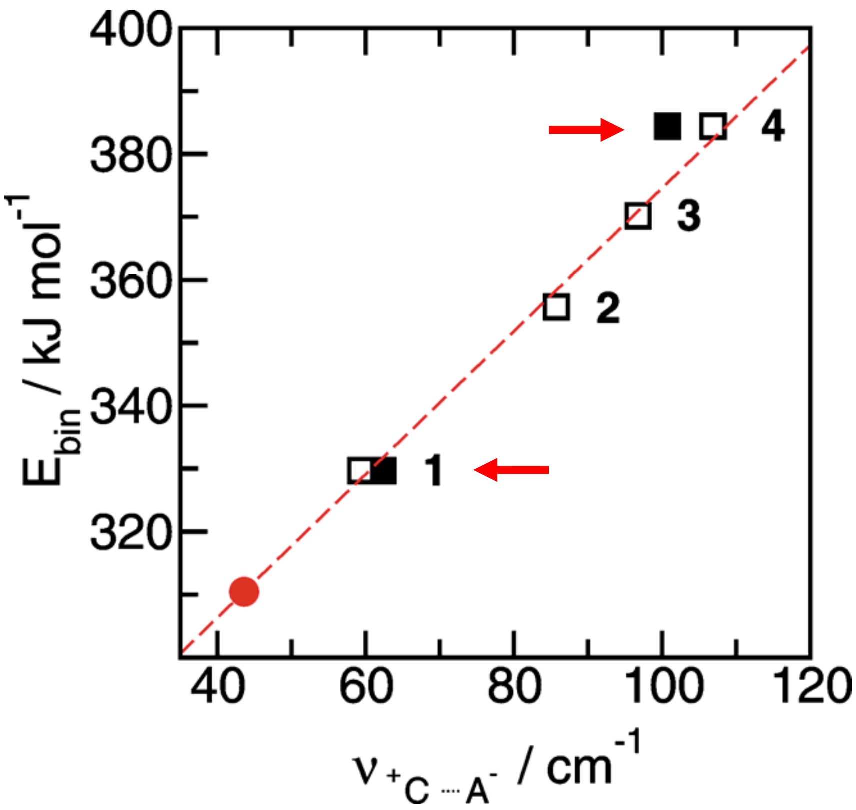
Beispiel 8: Ferninfrarot

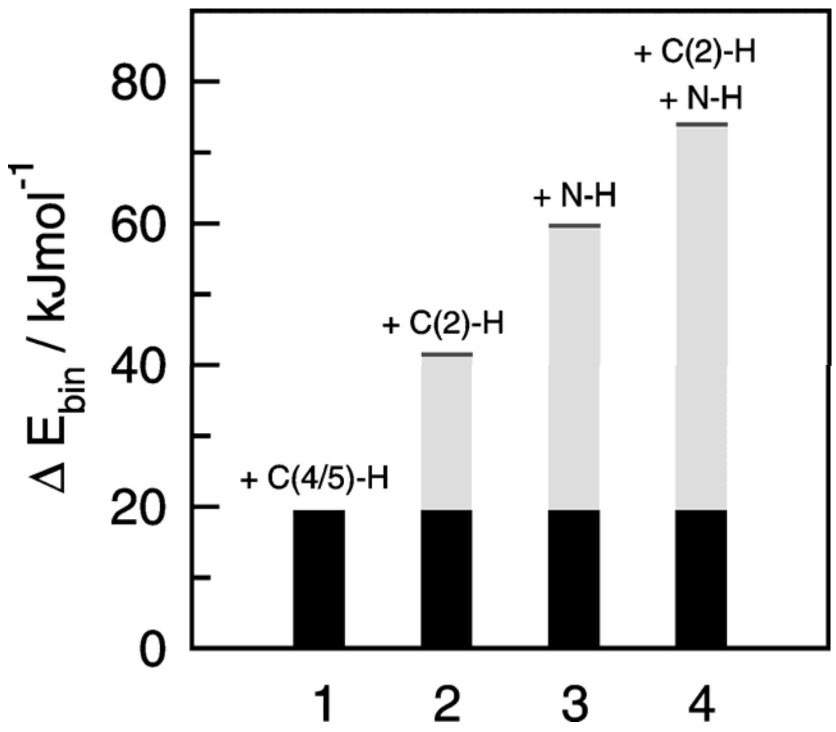




K. Fumino, A. Wulf, R. Ludwig, Angew. Chem., 2010,49, 449-453.

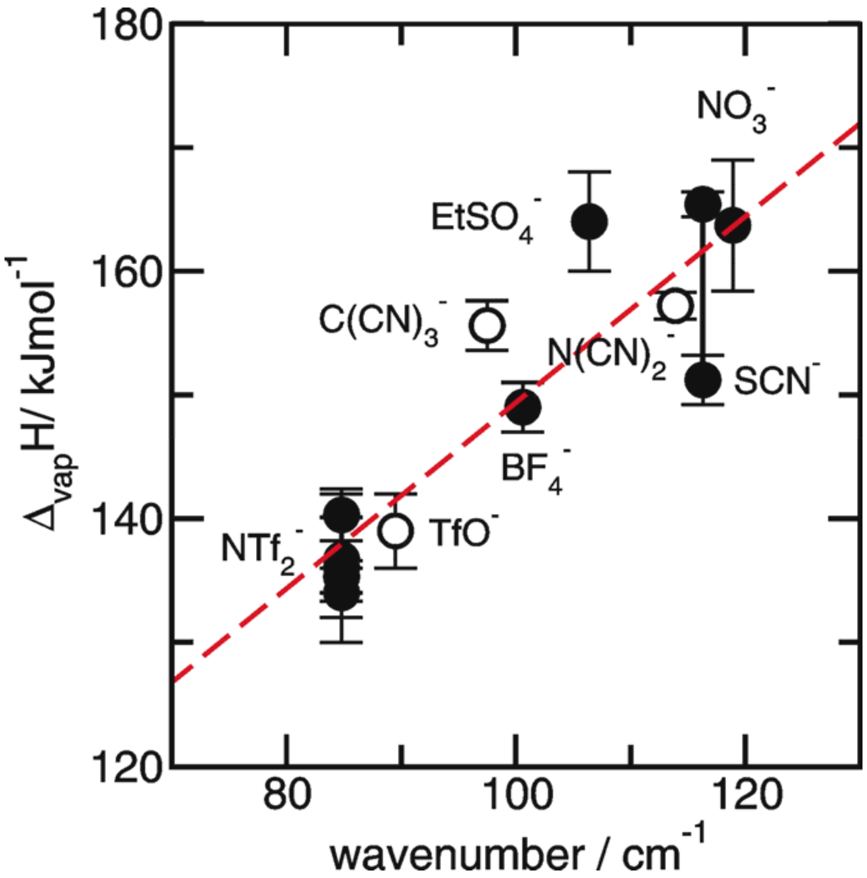
Beispiel 8: Ferninfrarot



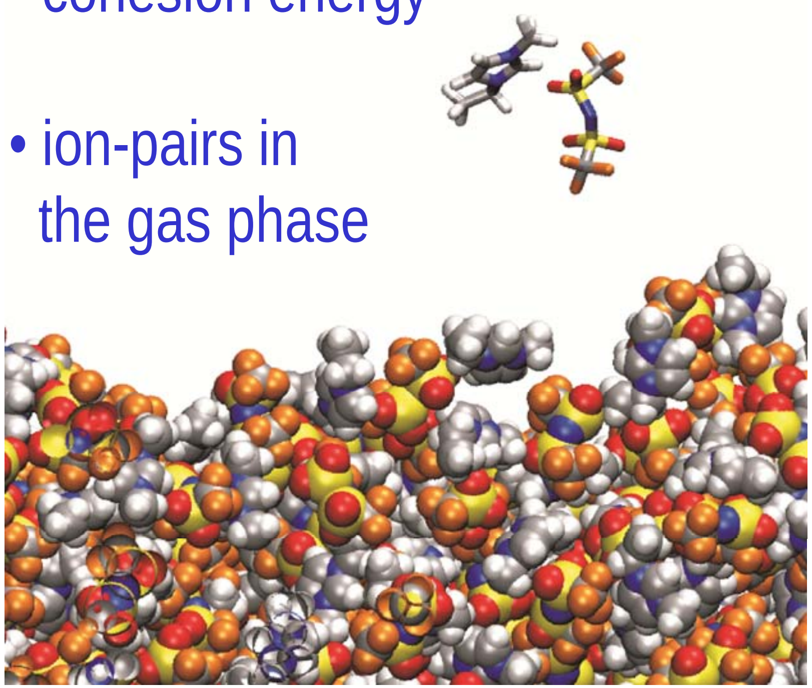


K. Fumino, A. Wulf, R. Ludwig, Angew. Chem., 2010,49, 449-453.

Beispiel 8: Ferninfrarot



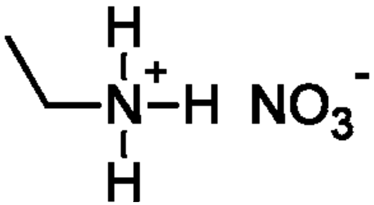
- cohesion energy
- ion-pairs in the gas phase

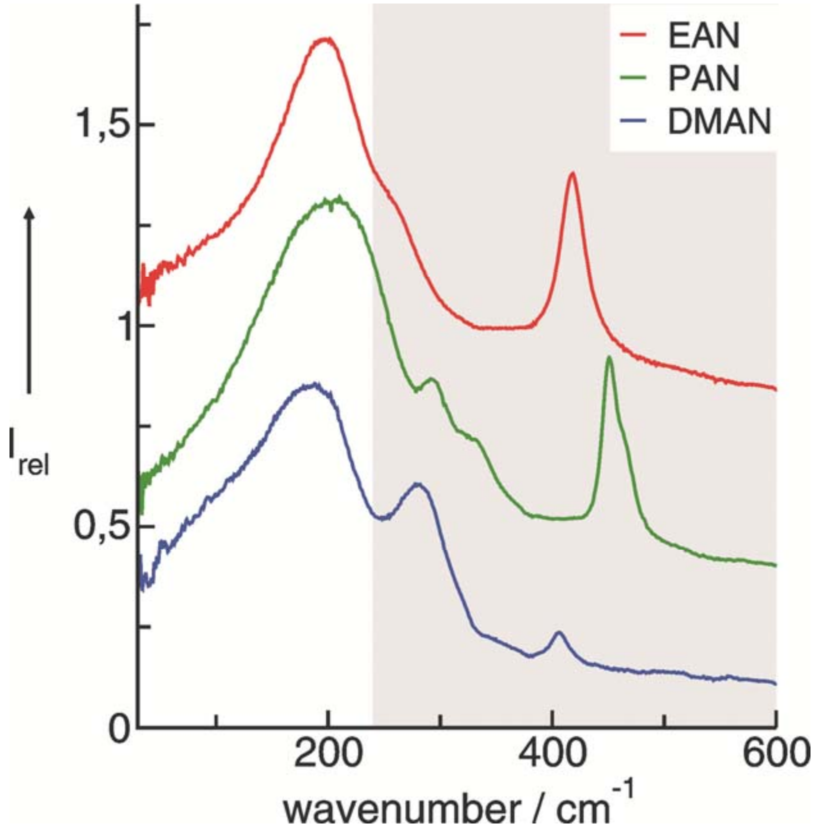


K. Fumino, A. Wulf, S. Verevkin, A. Heintz, R. Ludwig, ChemPhysChem, 2009, in print.

Beispiel 8: Ferninfrarot

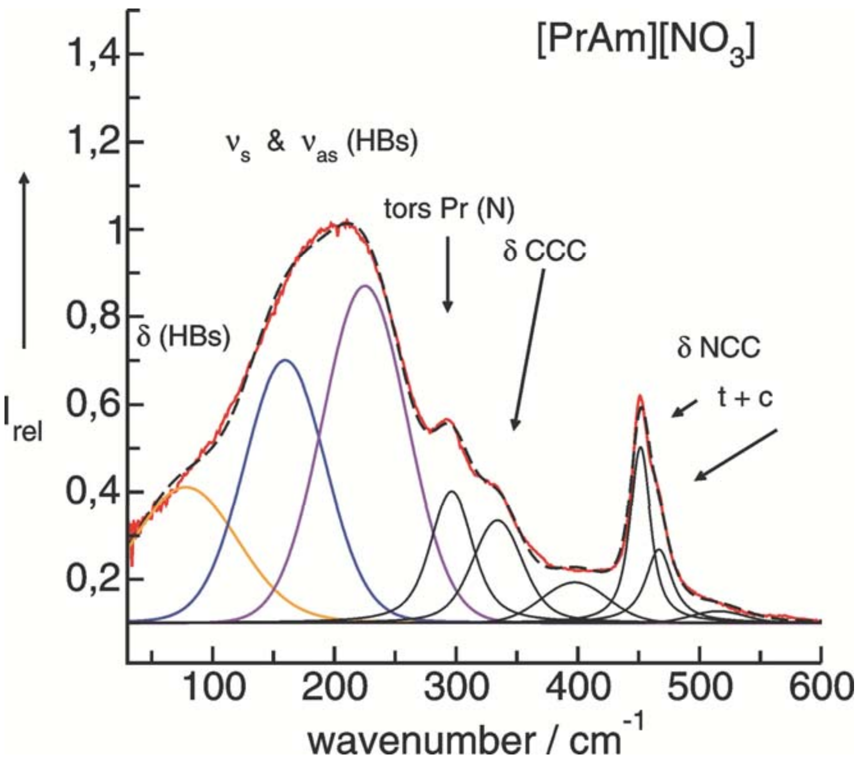
Paul Walden, 1863-1957
1919-1934 in Rostock

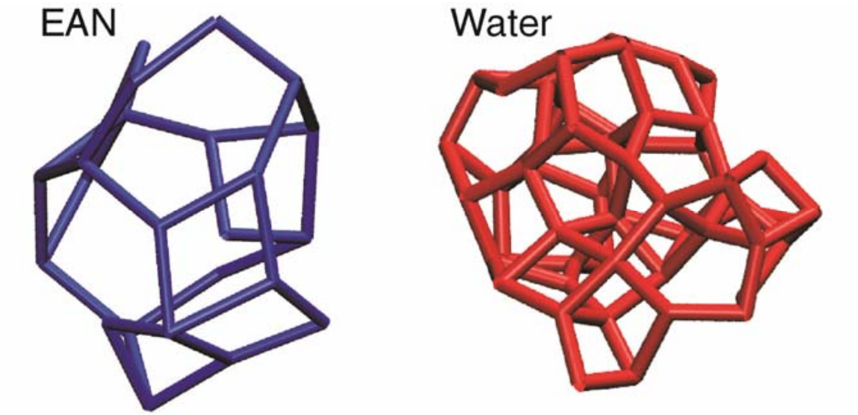




K. Fumino, A. Wulf, R. Ludwig, Angew. Chem., 2009, 48, 3184-3186 .

Beispiel 8: Ferninfrarot

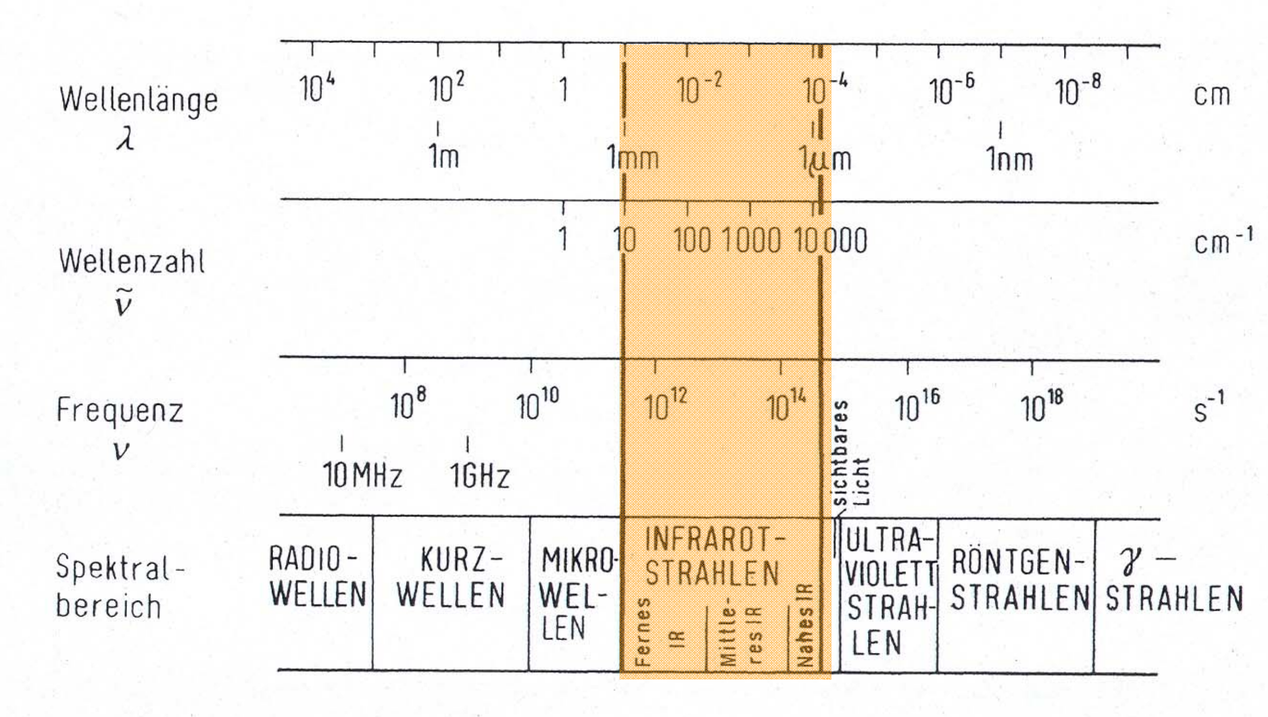




M. Allen, D. F. Evans, R. Lumry,
J. Solution Chem. 1985, 105, 1112-1117.

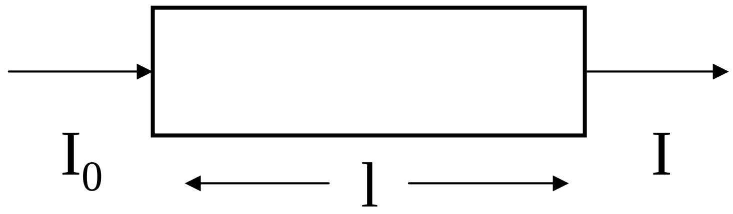
K. Fumino, A. Wulf, R. Ludwig, Angew. Chem., 2009, 48, 3184-3186 .

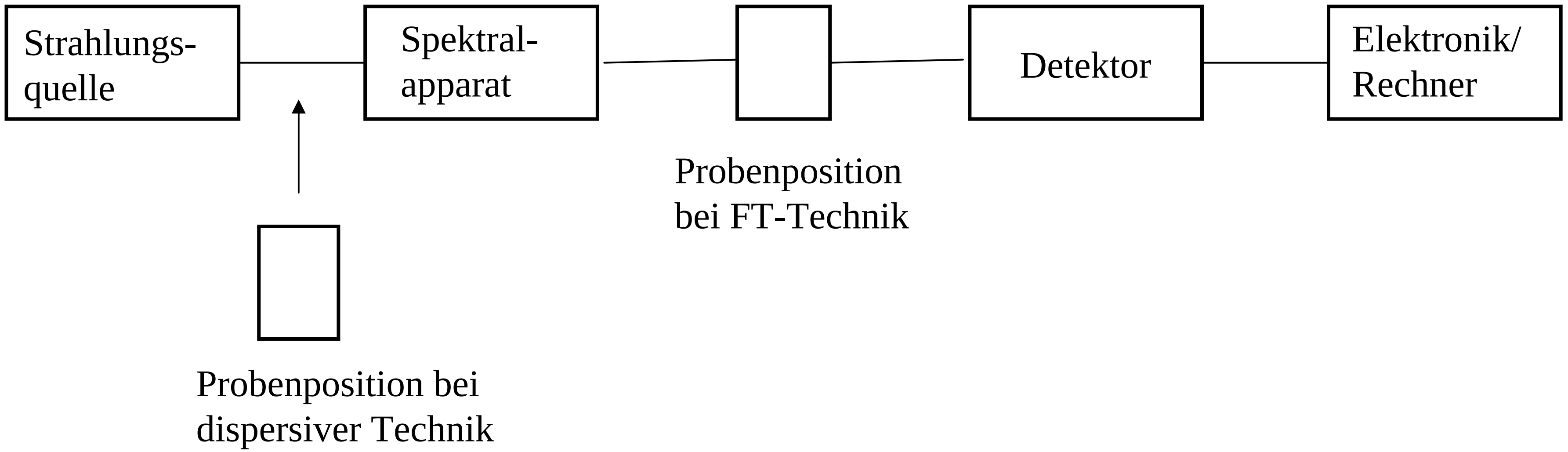
Elektromagnetisches Spektrum



IR-Spektrometer

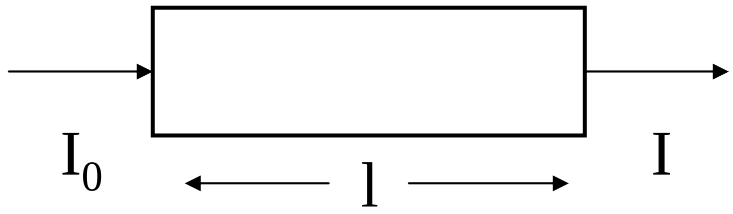
Absorptionexperiment:

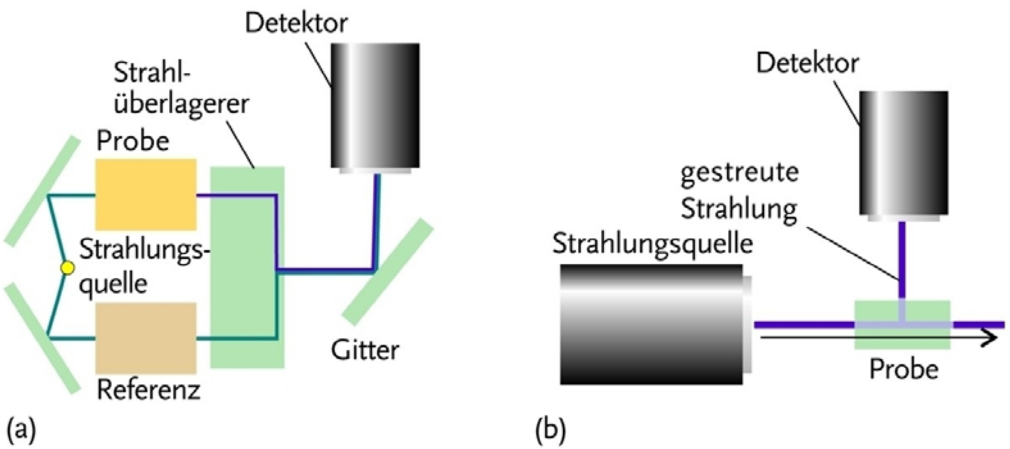


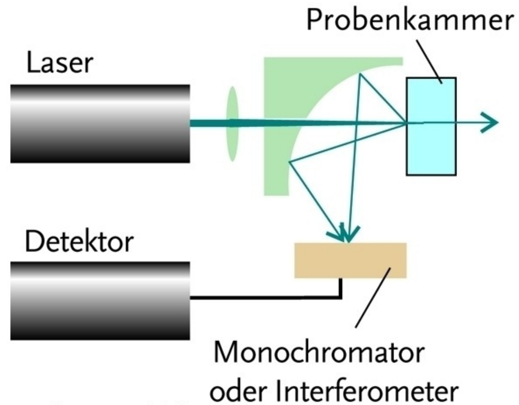


IR-Spektrometer

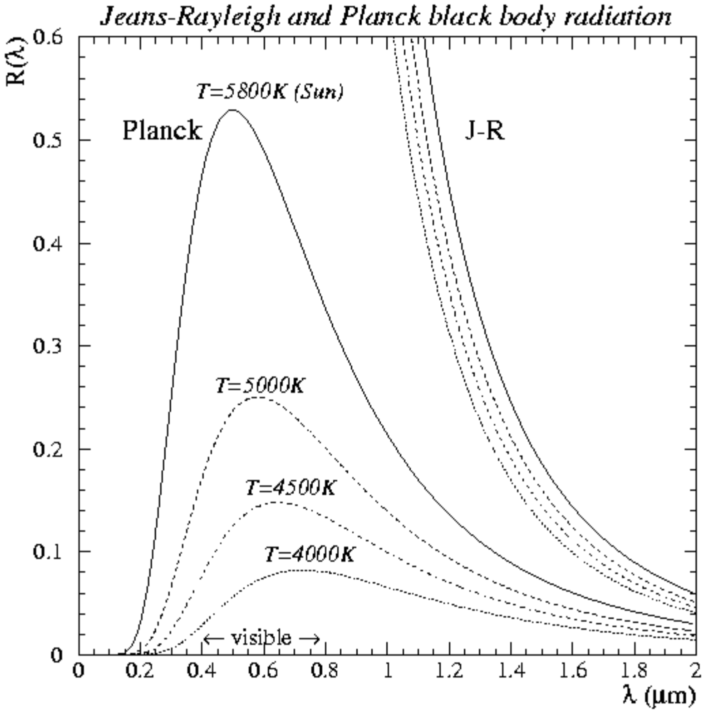
Absorptionexperiment:







IR-Strahlungsquelle

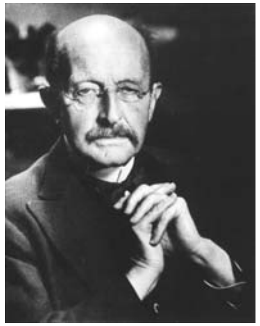


Globar: Siliciumcarbid, 1500 K, MIR, auch FIR

Nernst-Stift: Zirkoniumoxid, 1900 K, MIR

HG-Hochdrucklampe, <100 cm^{-1}, FIR

Laser, verschíedene Spektralbereiche



Plancksches Strahlungsgesetz:

$$\boxed{\rho'(\nu,T)\ d\nu = \frac{8\pi\nu^3 h}{c^3}\left(e^{h\nu/kT}-1\right)^{-1} d\nu}$$

IR-Detektoren

Strahlungsempfänger = Detektoren

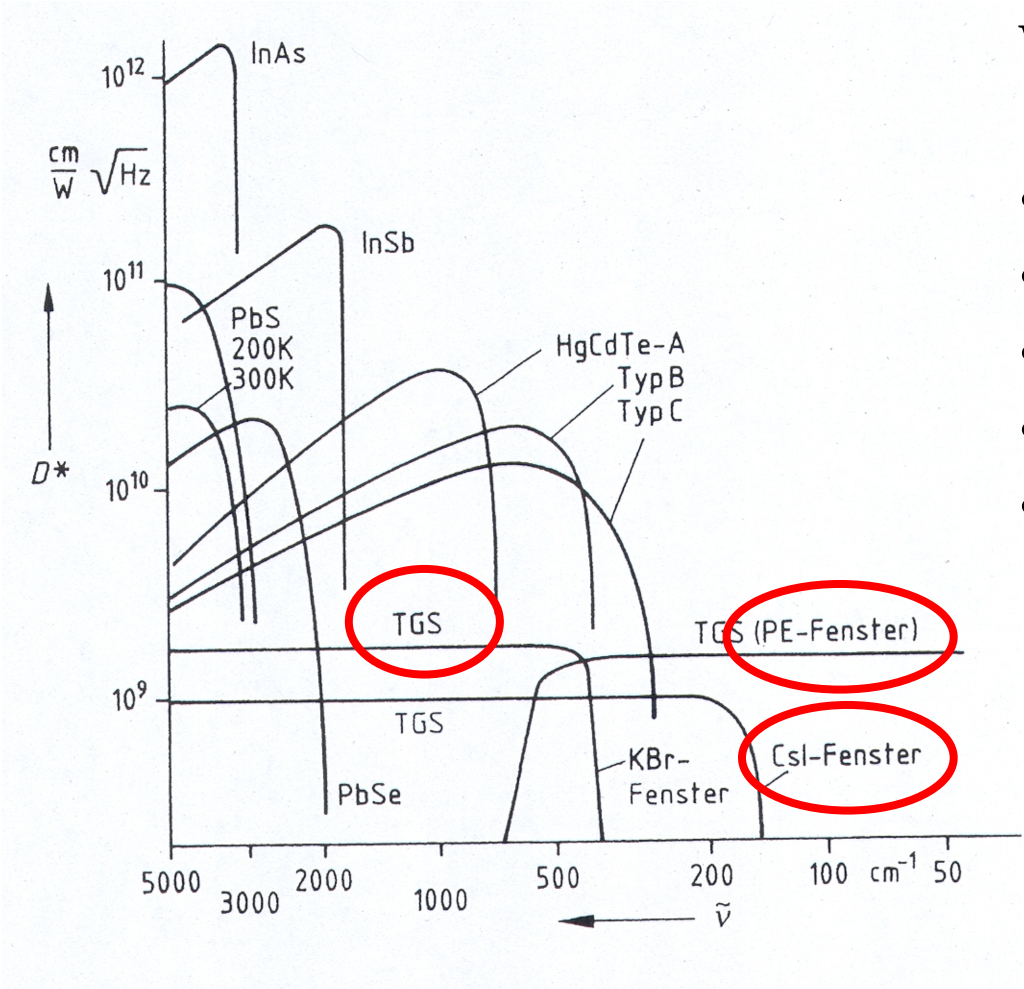
Thermische Detektoren: Änderung der Temperatur

Bolometer: Änderung der elektrischen Leitfähigkeit

Thermoelemente: Änderung der Thermospannung

Photoelektrische Detektoren: Halbleitermaterialien,
Photospannung
lichtelektrischer Effekt

IR-Detektoren

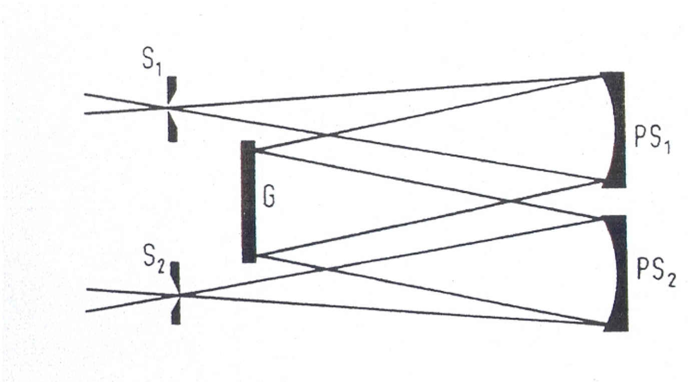


Wichtige Kriterien:

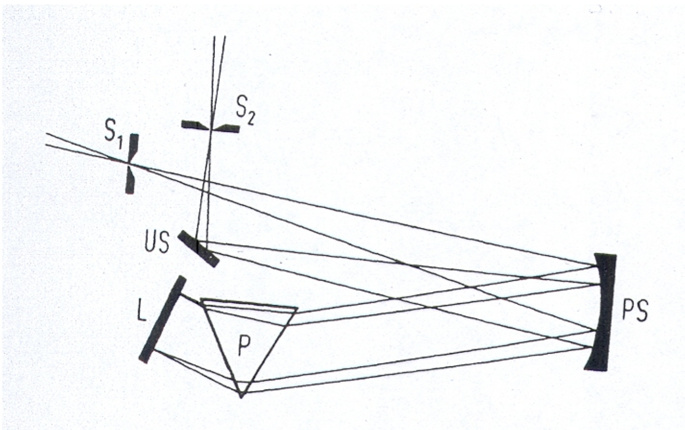
- Lebensdauer
- Wellenlängenbereich
- Empfindlichkeit
- Signal-zu-Rausch-Verhältnis
- Zeitkonstante der Ansprechgeschwindigkeit

TGS: Triglycinsulfat

Dispersive IR-Spektrometer

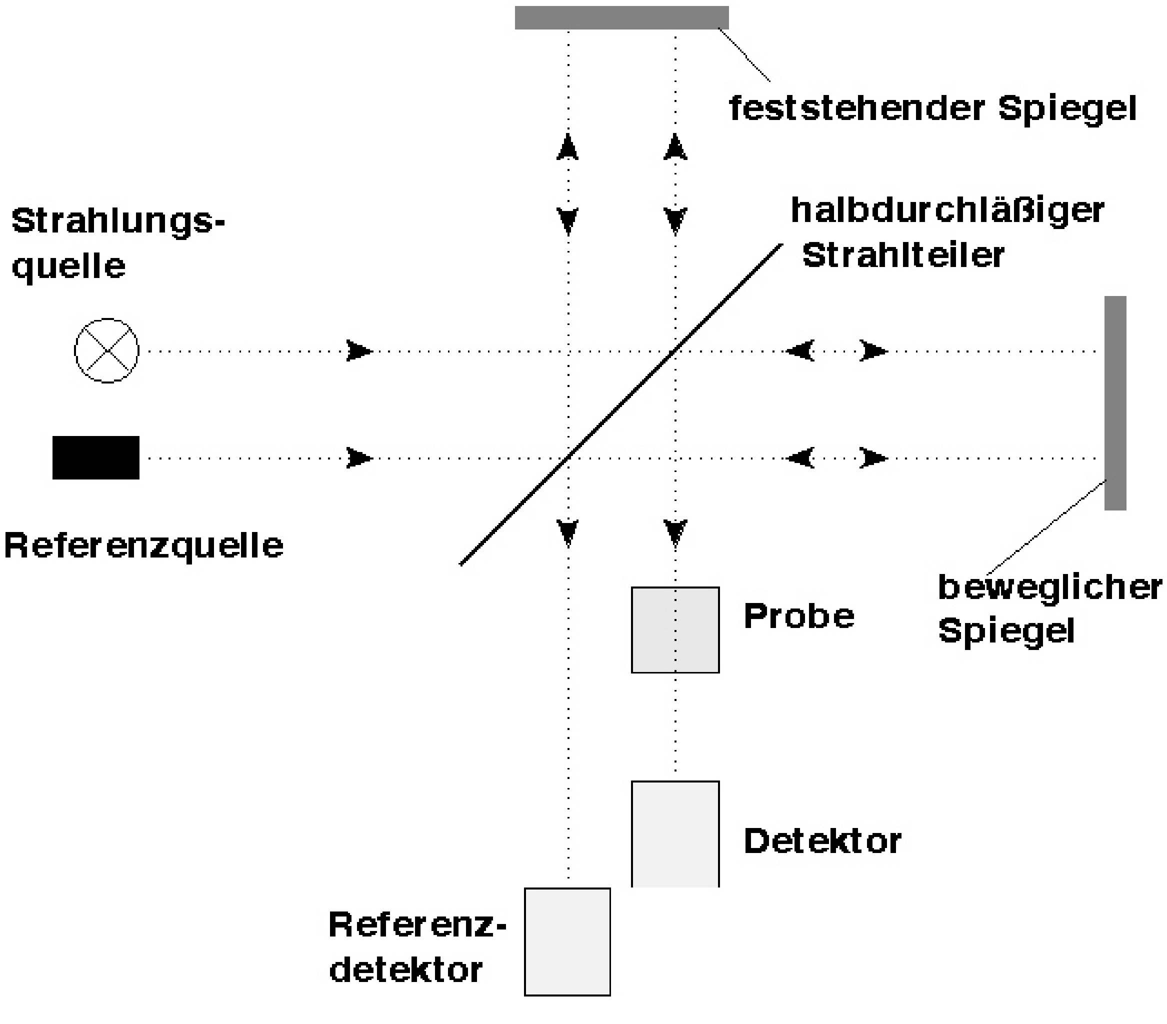


Gittermonochromator
in Ebert-Anordnung



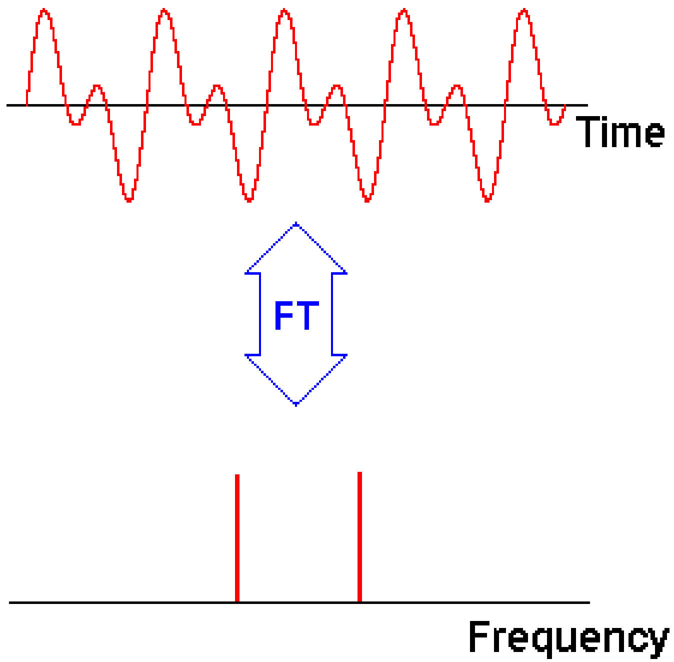
Prismenmonochromator
in Littrow-Anordnung

Michelson-Interferometer



Fourier-Transformation

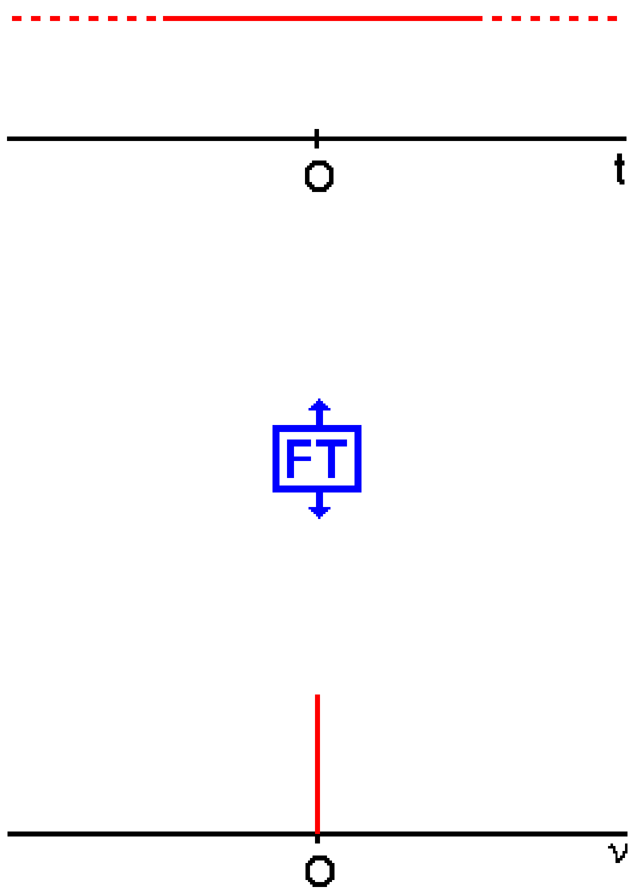
$$f(\omega) = \int_{-\infty}^{\infty} f(t)\, e^{-i\omega t}\, dt$$



Fourier-Transformation

konstanter Wert:

Delta-Funktion bei 0:



Fourier-Transformation

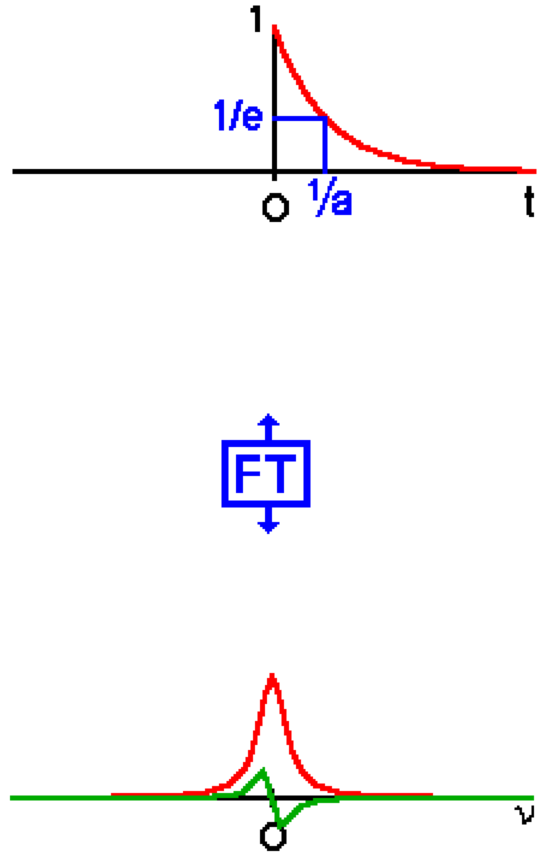
e^{-at} für $t > 0$

$$\boxed{f(\omega) = \int_{-\infty}^{\infty} f(t)\, e^{-i\omega t}\, dt}$$

Lorentz-Kurve

RE: $a^2/(a^2+\omega^2)$

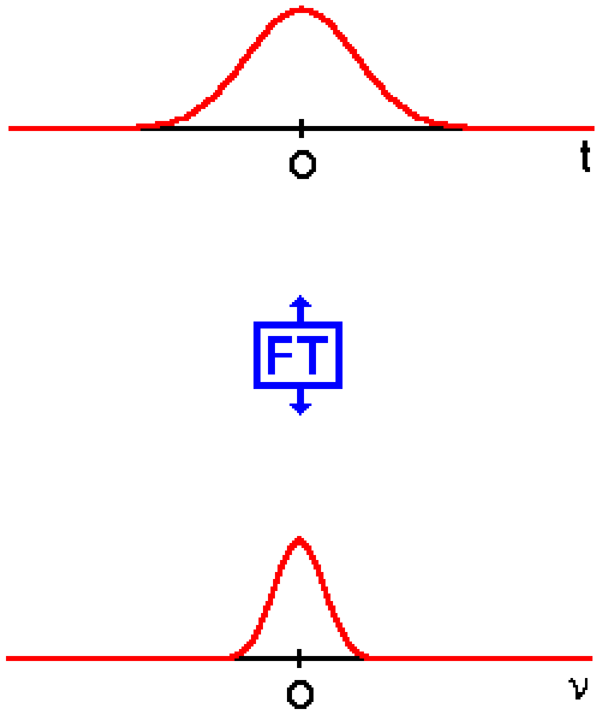
IM: $a^2\omega/(a^2+\omega^2)^2$



Fourier-Transformation

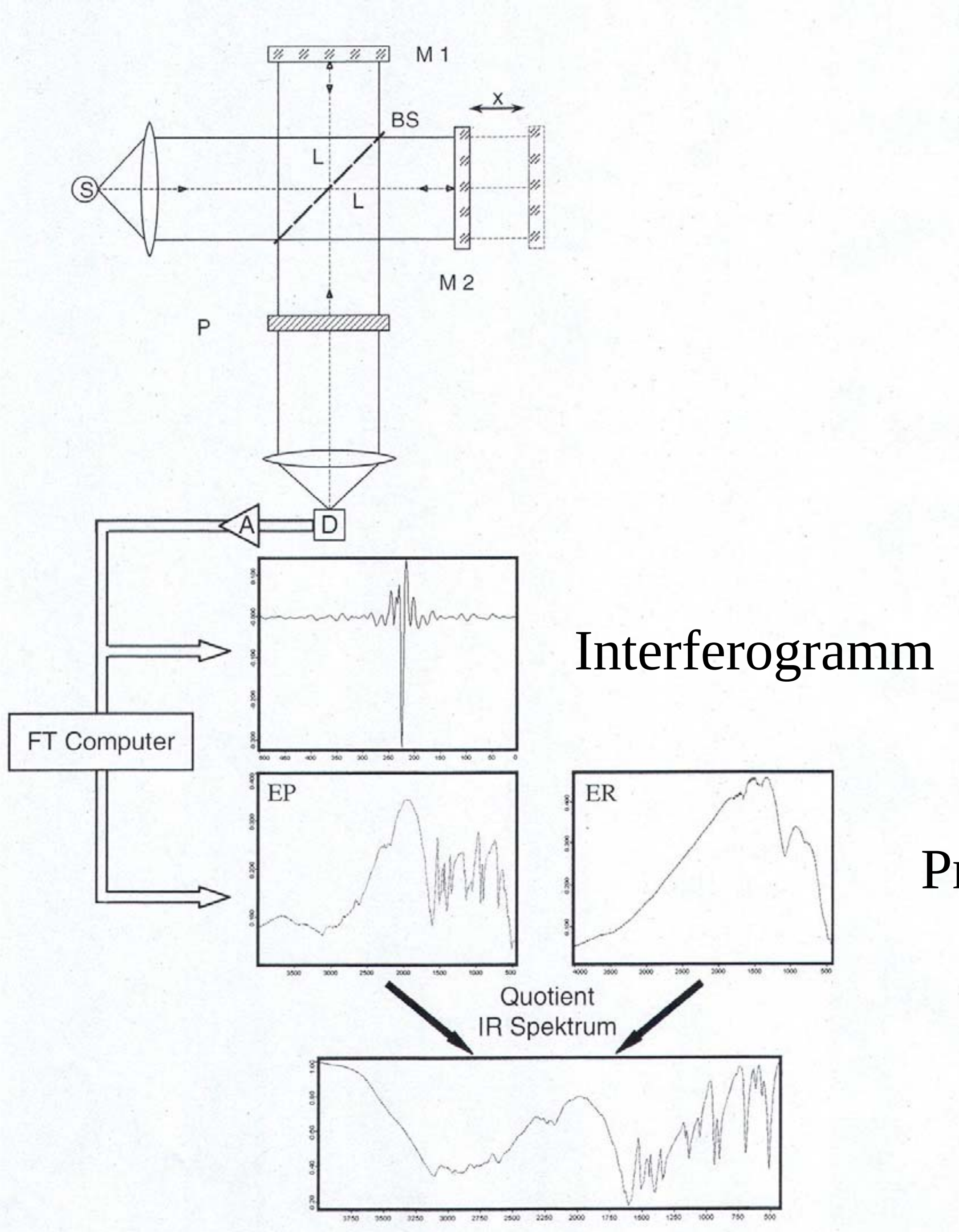
Gauss-Funktion:
$\exp(-t^2/2a^2)$

$$\boxed{f(\omega) = \int_{-\infty}^{\infty} f(t)\, e^{-i\omega t}\, dt}$$



Gauss-Funktion:
$\exp(-a^2\omega^2/2)$

Fourier-Transform IR-Spektrometer



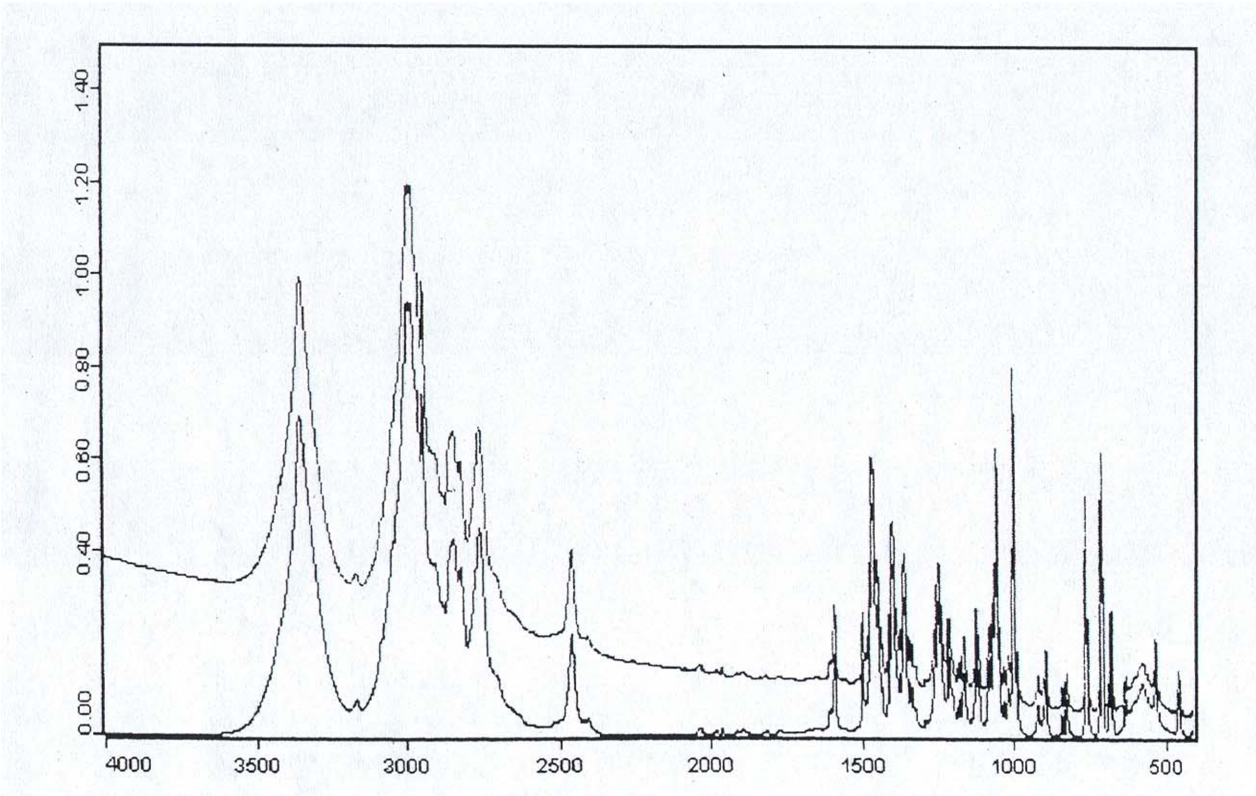
Interferogramm

Vorteile:
Gesamter Spektralbereich
Rayleigh-Kriterium:
$R=1/2x$ (cm^{-1})

Probe

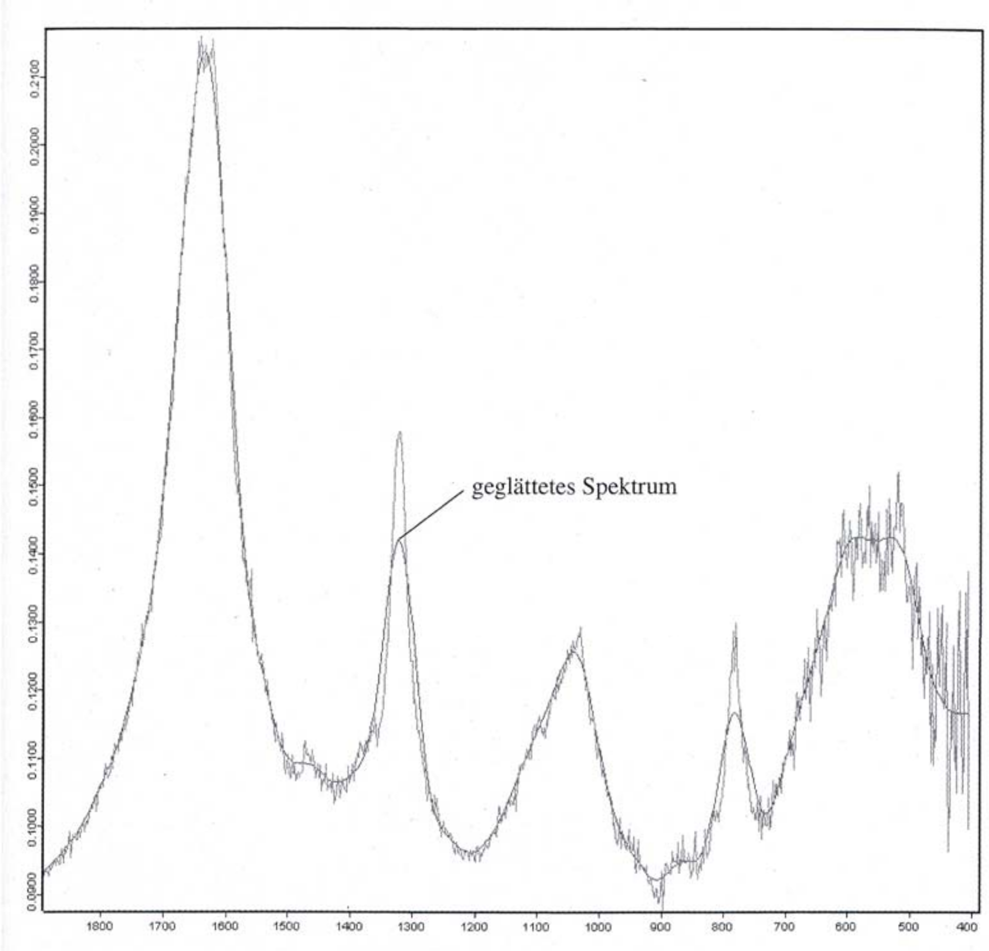
Referenz

Spektrenbearbeitung



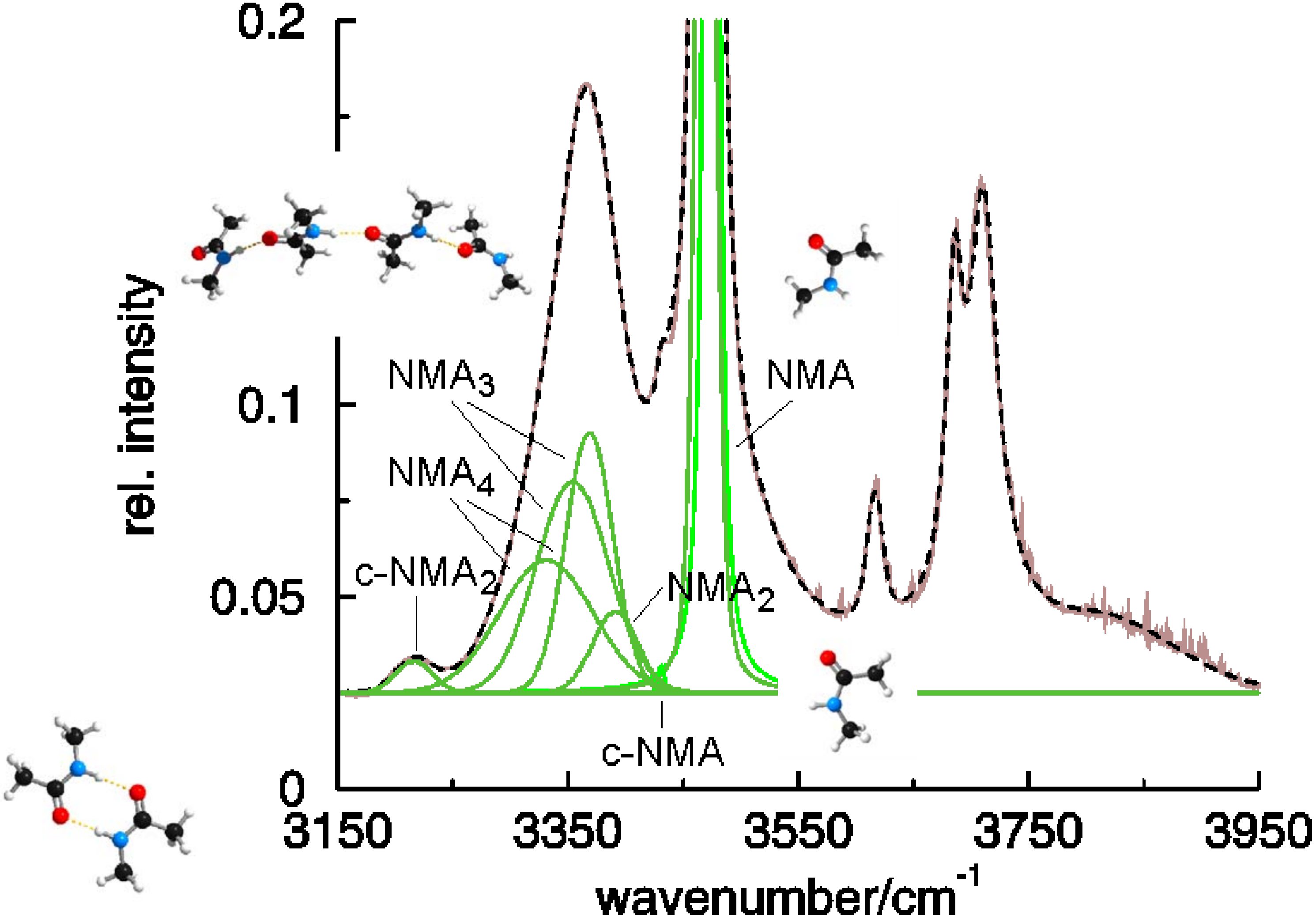
Basislinienkorrektur

Spektrenbearbeitung

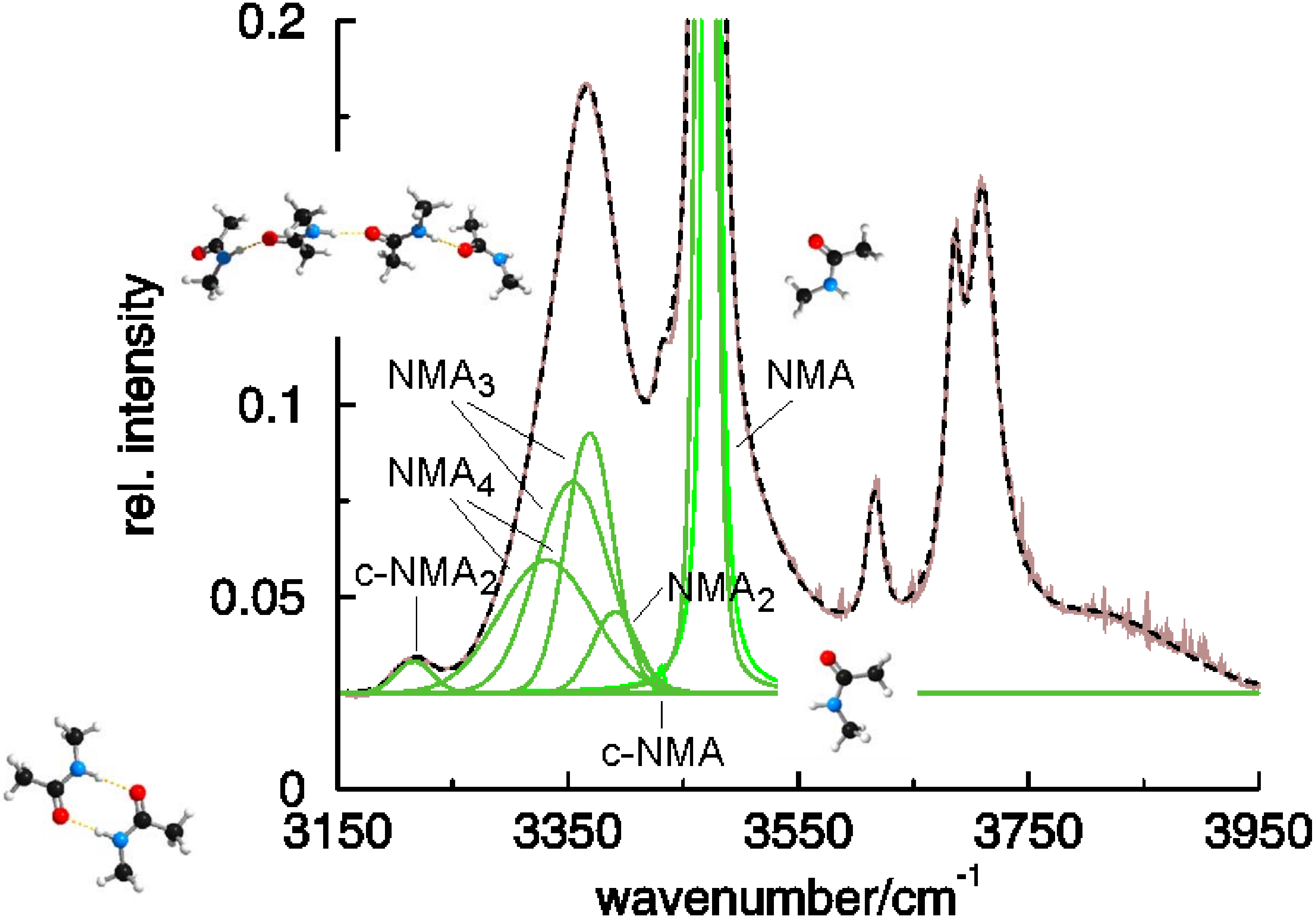


Glättung einer Kurve

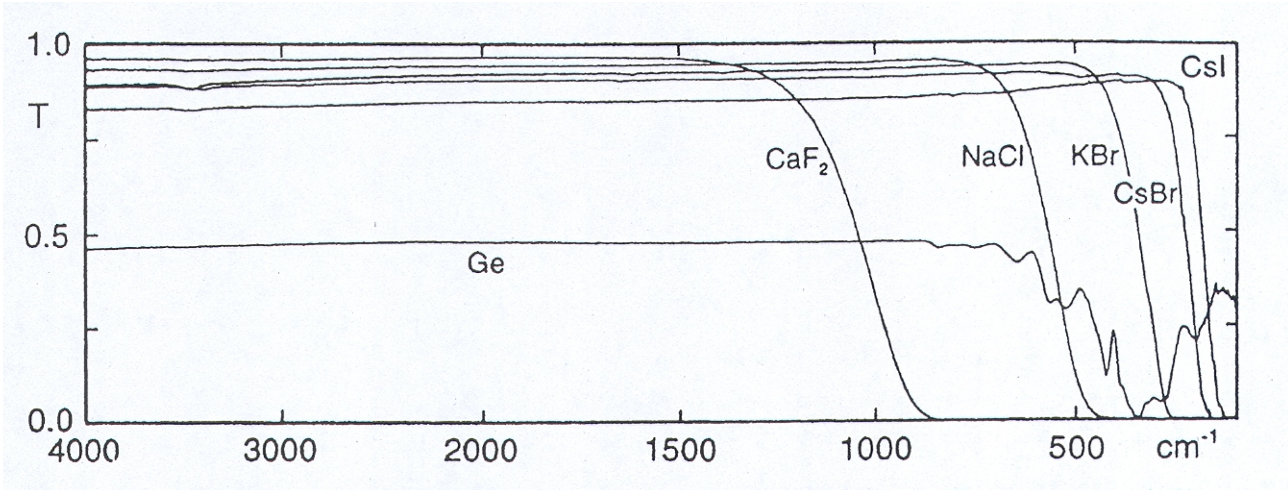
Beispiel 6: NMA-Wasser-Cluster

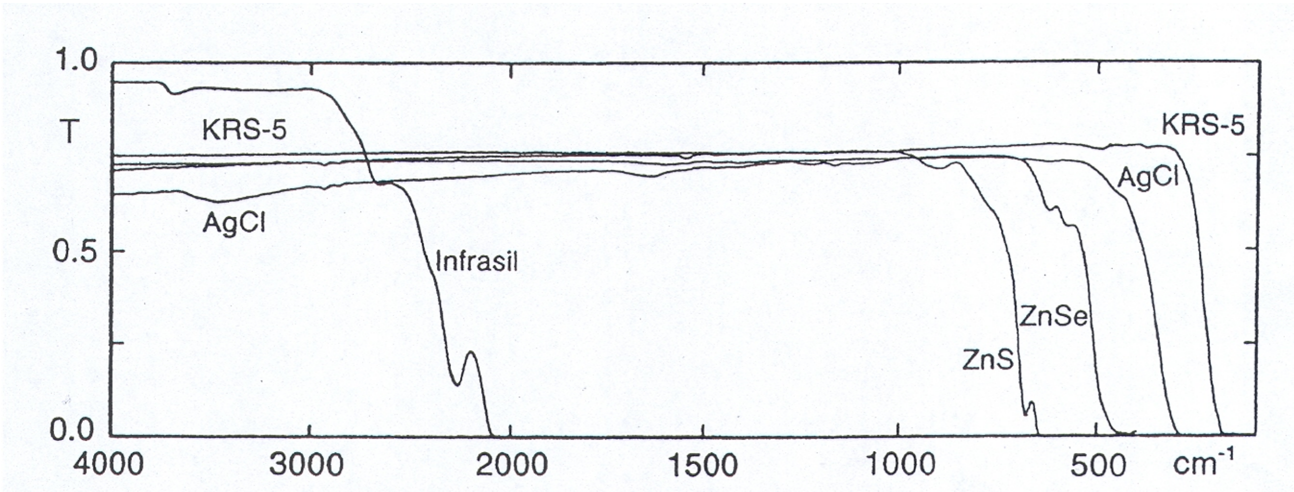


Spektrenbearbeitung

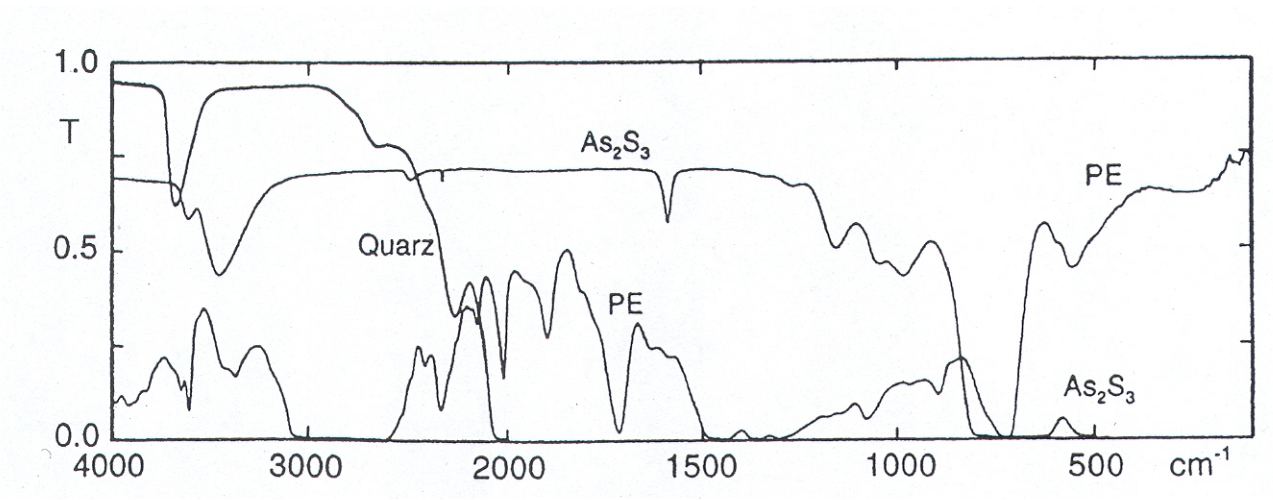


Küvetten


1.0
T
0.5
0.0
4000
3000
2000
1500
1000
500
cm-1
CsI
CaF2
NaCl
KBr
CsBr
Ge

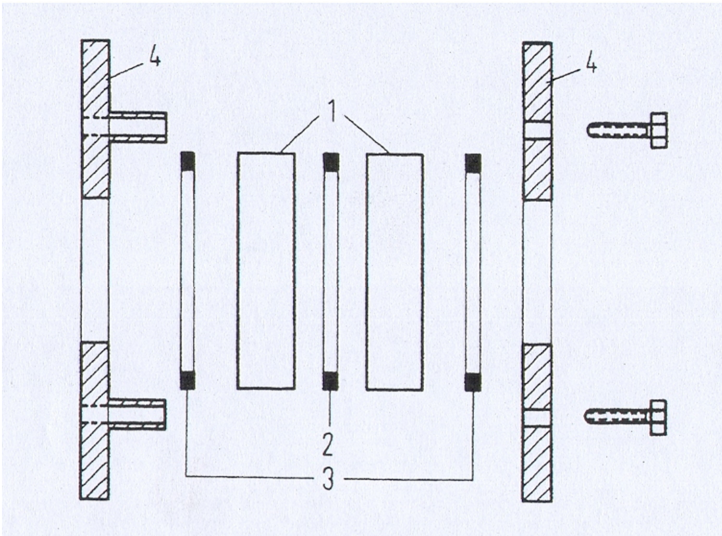

1.0
T
0.5
0.0
4000
3000
2000
1500
1000
500
cm-1
KRS-5
AgCl
Infrasil
KRS-5
AgCl
ZnSe
ZnS

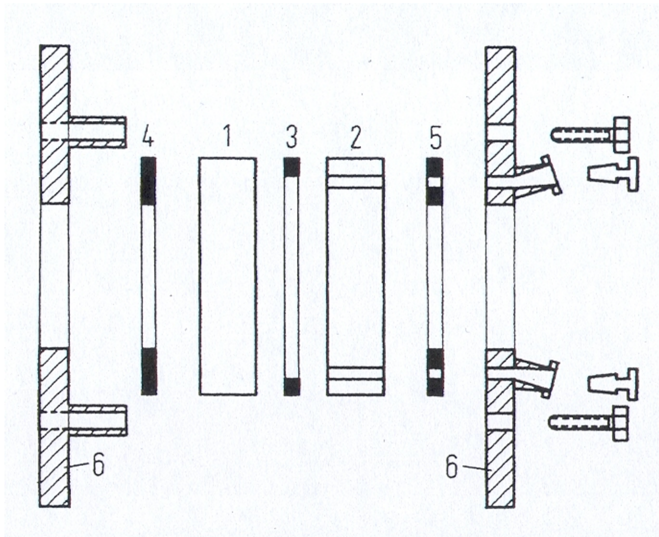
Küvetten



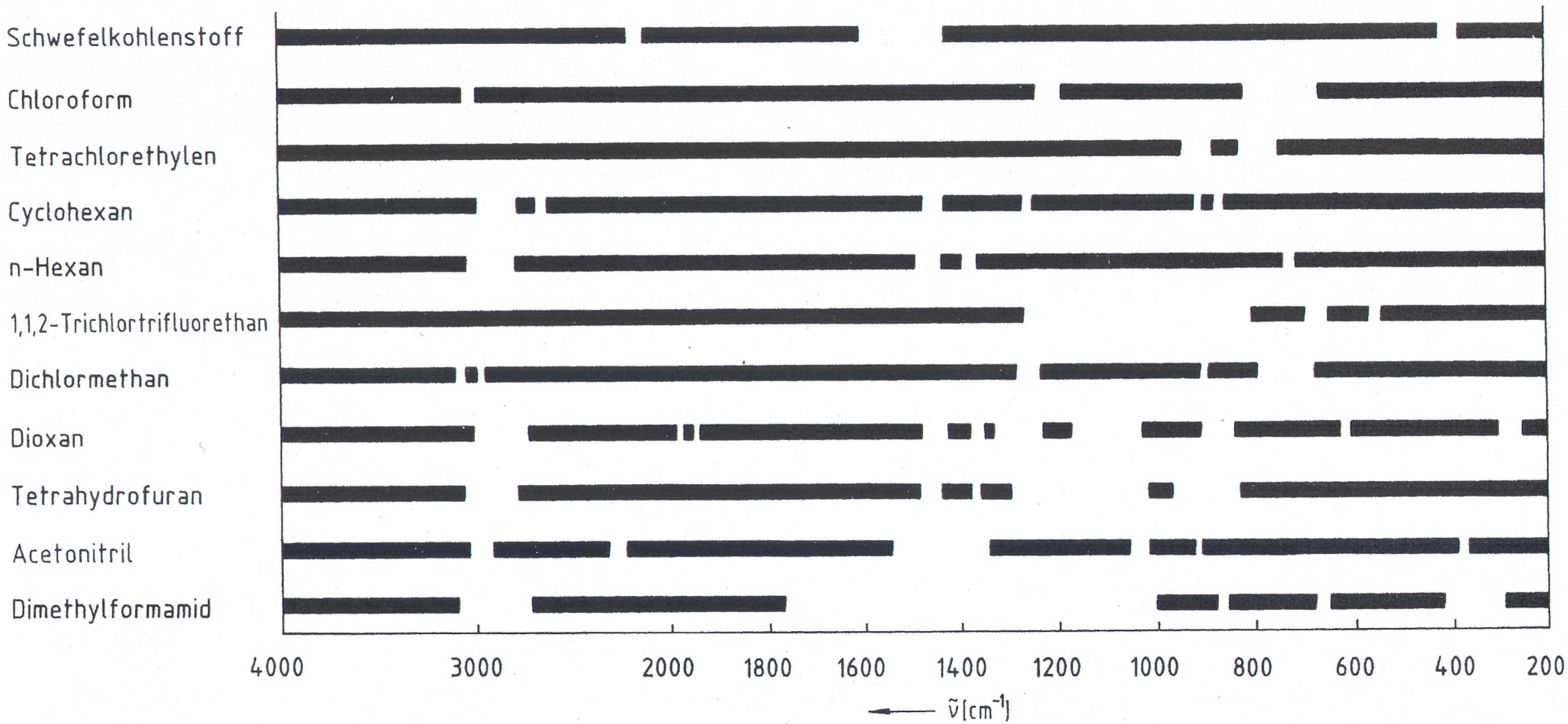
1.0
T
0.5
0.0
4000
3000
2000
1500
1000
500
cm-1
As2S3
PE
Quarz
PE
As2S3

Küvetten

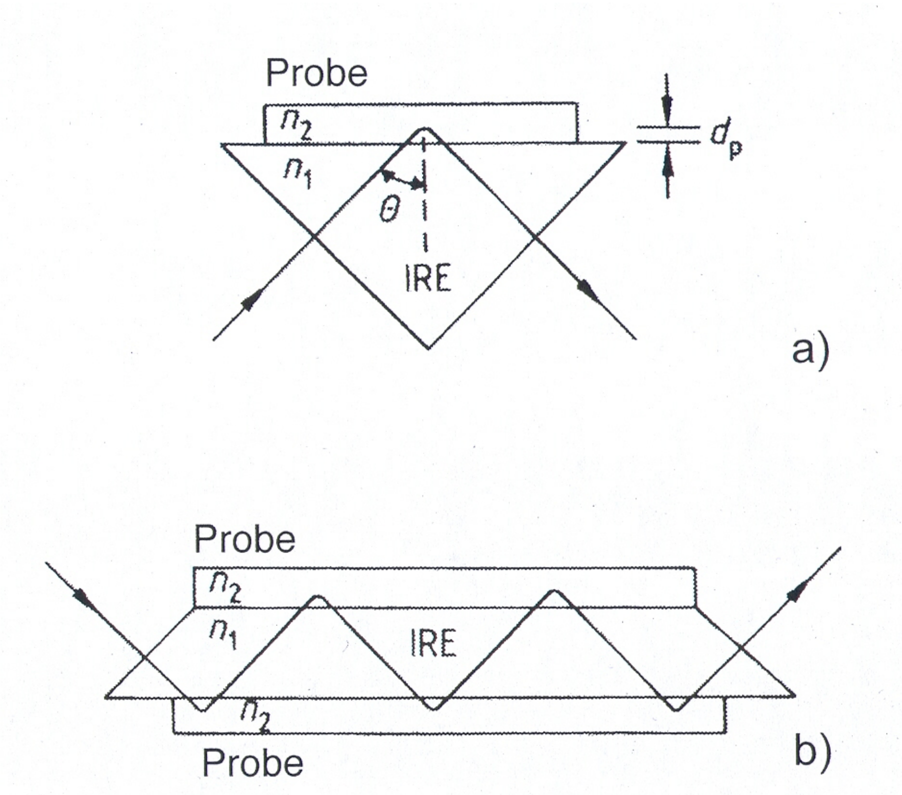




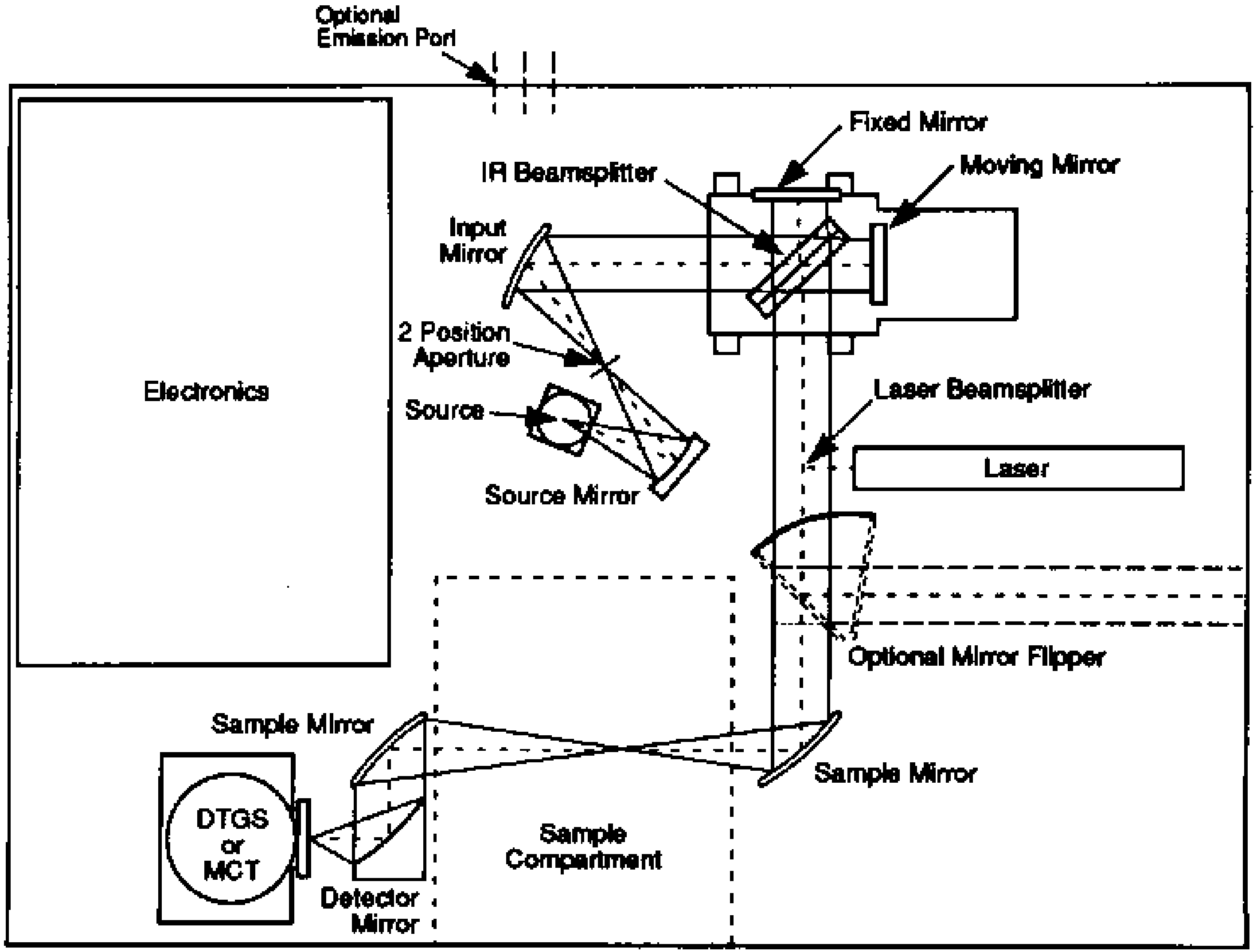
Lösungsmittel



Abgeschwächte Totalreflexion



IR-Spektrometer



IR-Spektrometer

IR-Spektrometer

IR Einführung