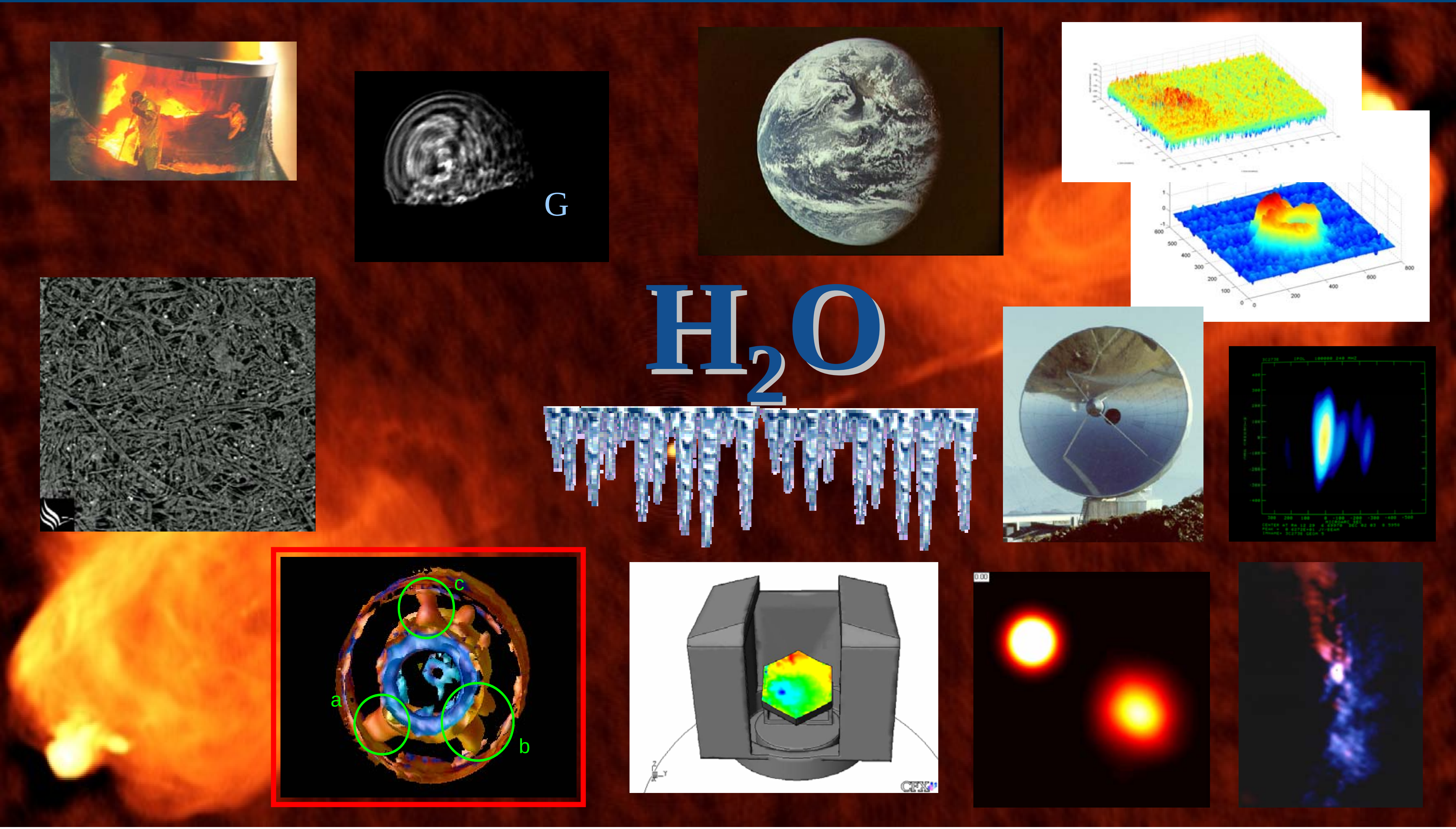
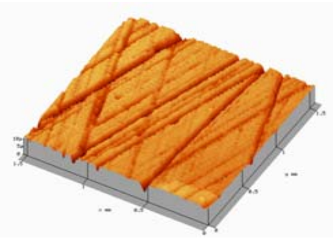
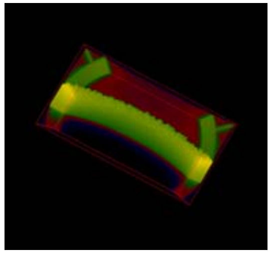


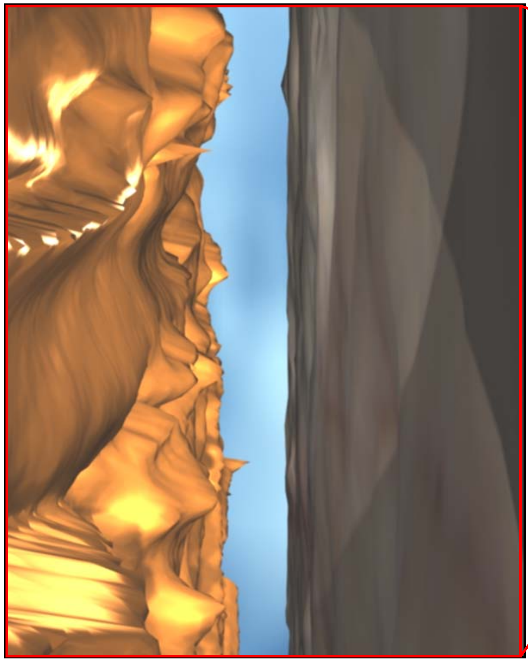

# Functional Surfaces group Halmstad

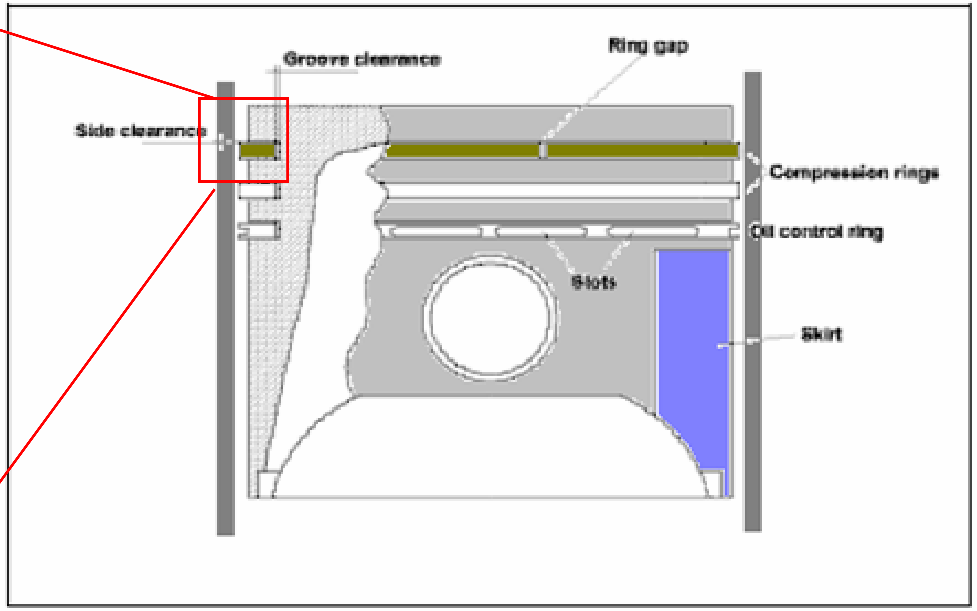
Winterwind Åsele 2008

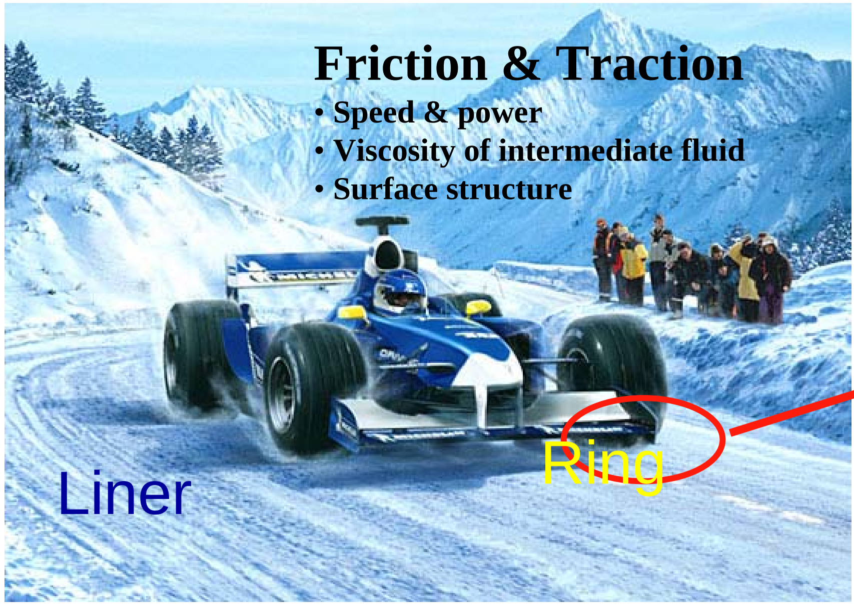
Lars Bååth Halmstad University

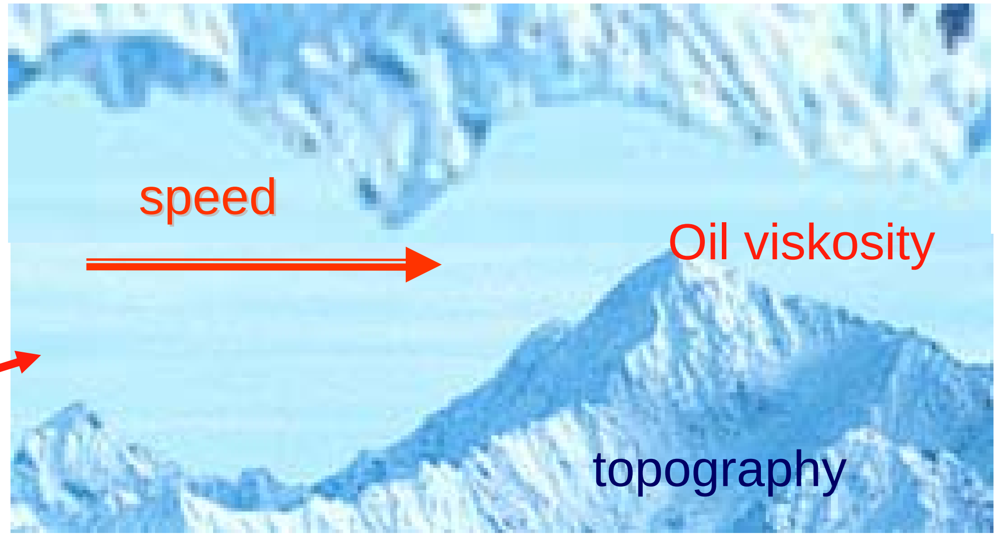


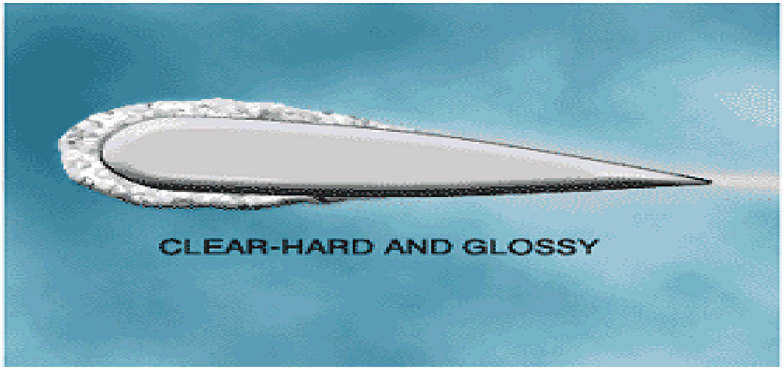




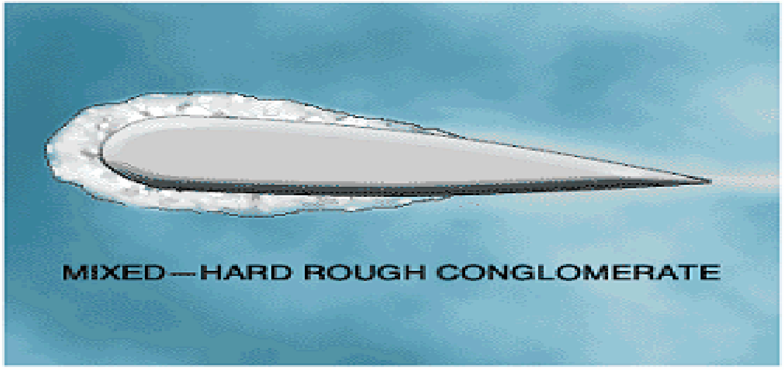

Groove clearance
Ring gap
Side clearance
Compression rings
Oil control ring
Slots
Skirt


Friction & Traction
• Speed & power
• Viscosity of intermediate fluid
• Surface structure
Ring
Liner

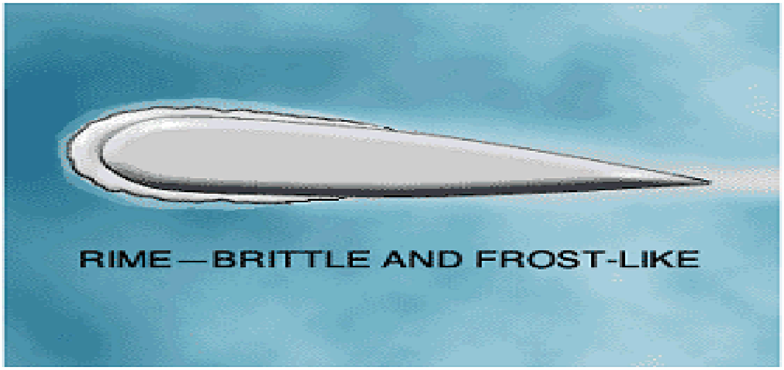

speed
Oil viskosity
topography




Sideview of wing with clear ice




Sideview of wing with mixed ice




Sideview of wing with rime.

Aircraft Antiicing Systems Mehl&Parsons NASA

**- Icing is caused by super-cooled liquid water drops**

- **cloud water drops ∅ <50µm**
- **freezing drizzle ∅ 50µm – 500µm**
- **freezing rain ∅ >500µm**

**- Or by sublimation (direct freezing of water vapor)**

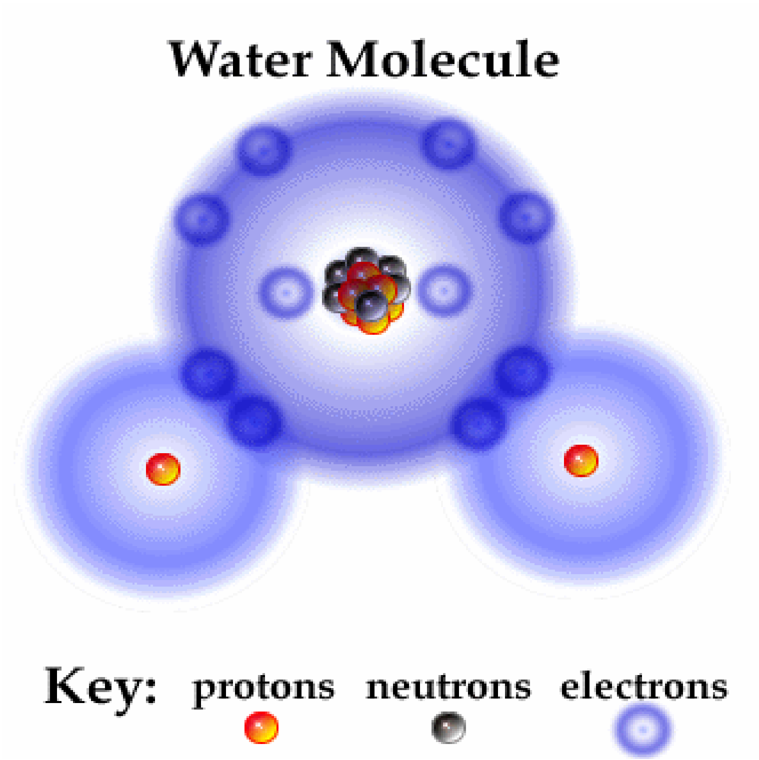
**Icing type is dependent on temperature as suggested in the following table:**

| | | |
|---|---|---|
| **Clear** | **0° C to -10° C** | **- drops have time to flow before freezing** |
| **Mixed** | **-10° C to -15° C** | |
| **Rime** | **-15° C to - 40° C** | **- drops freeze immediately** |

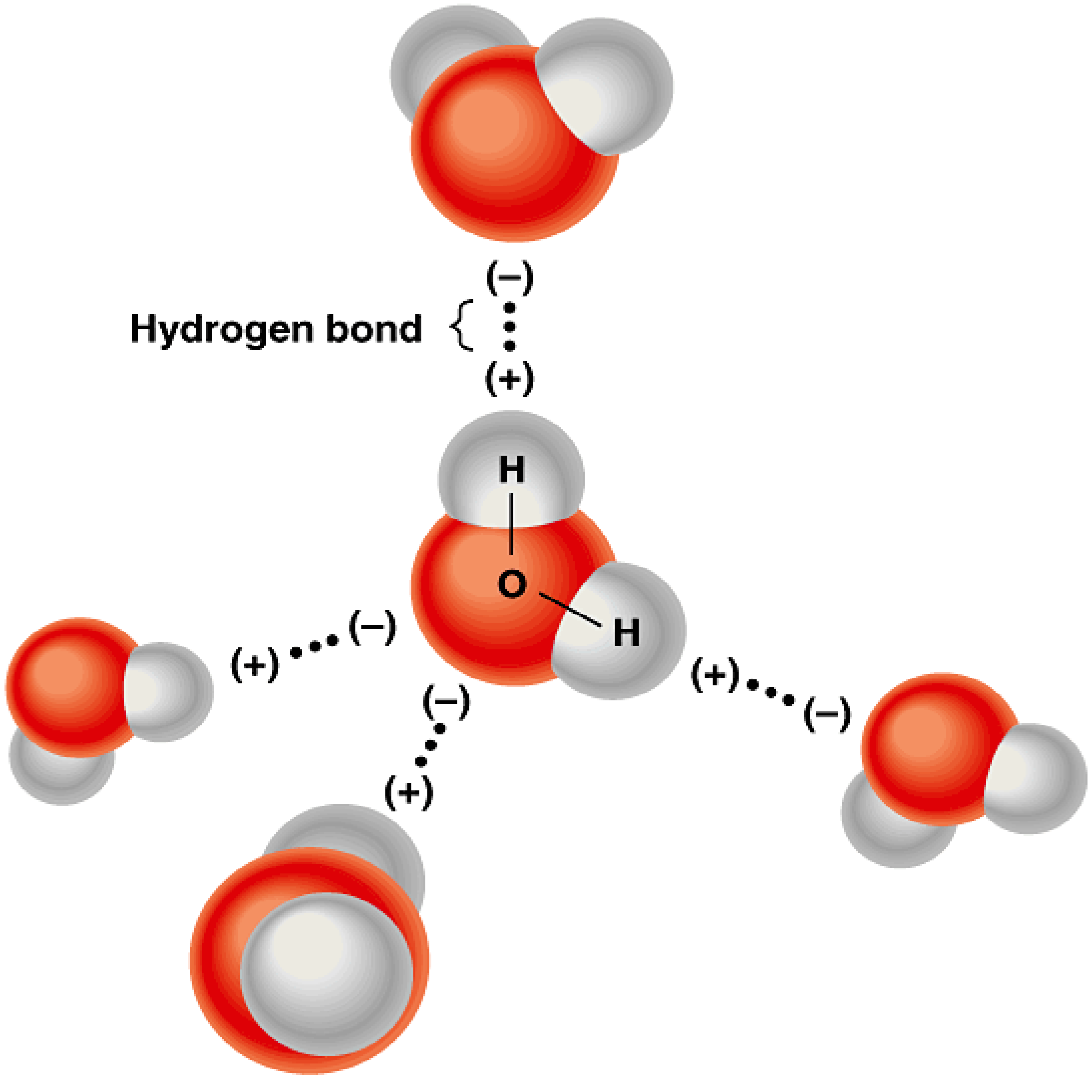
# Bonding

## Covalent bonding

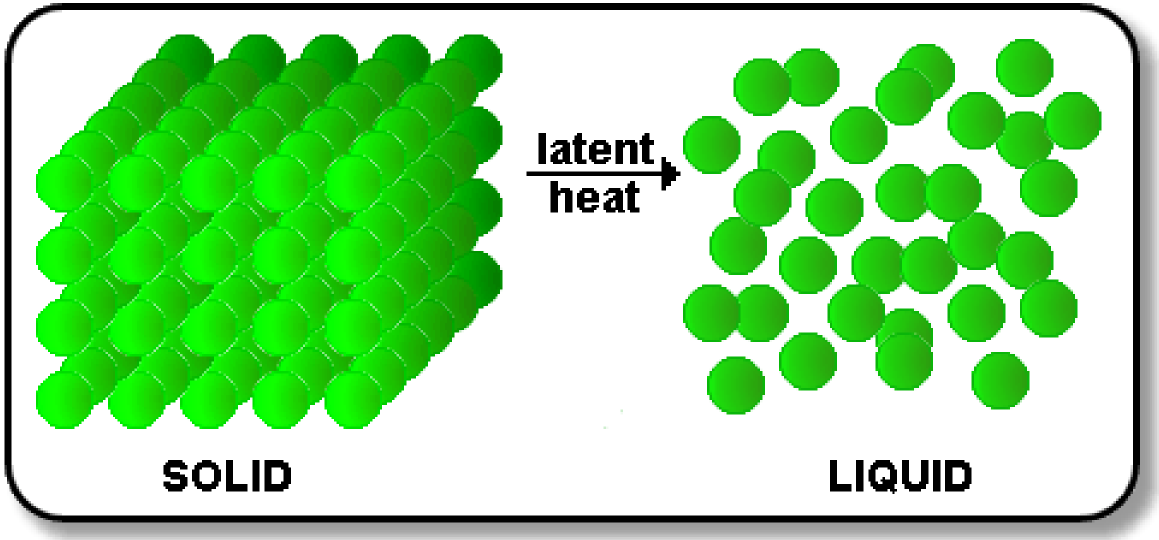
## Polar covalent bond

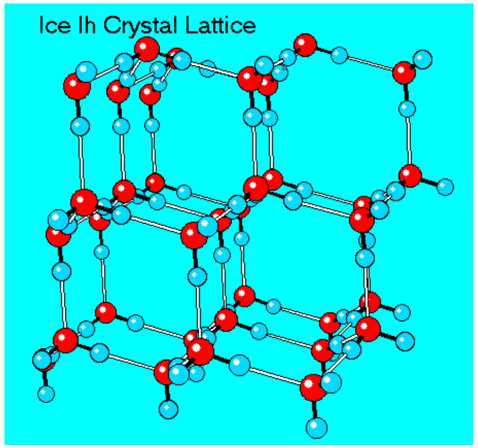



From Chemistry and Biochemistry



# Ice to Water




## *Specific heat (heating):*

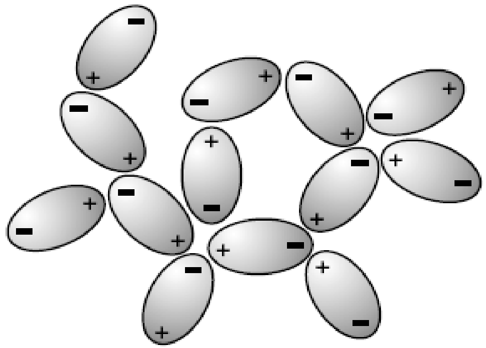
- *ice* *2 J/g/°C*
- *water* *4 J/g/°C*

## *Thermal conductivity:*

- *ice* *1.88 W/m/°C*
- *water* *0.57 W/m/°C*

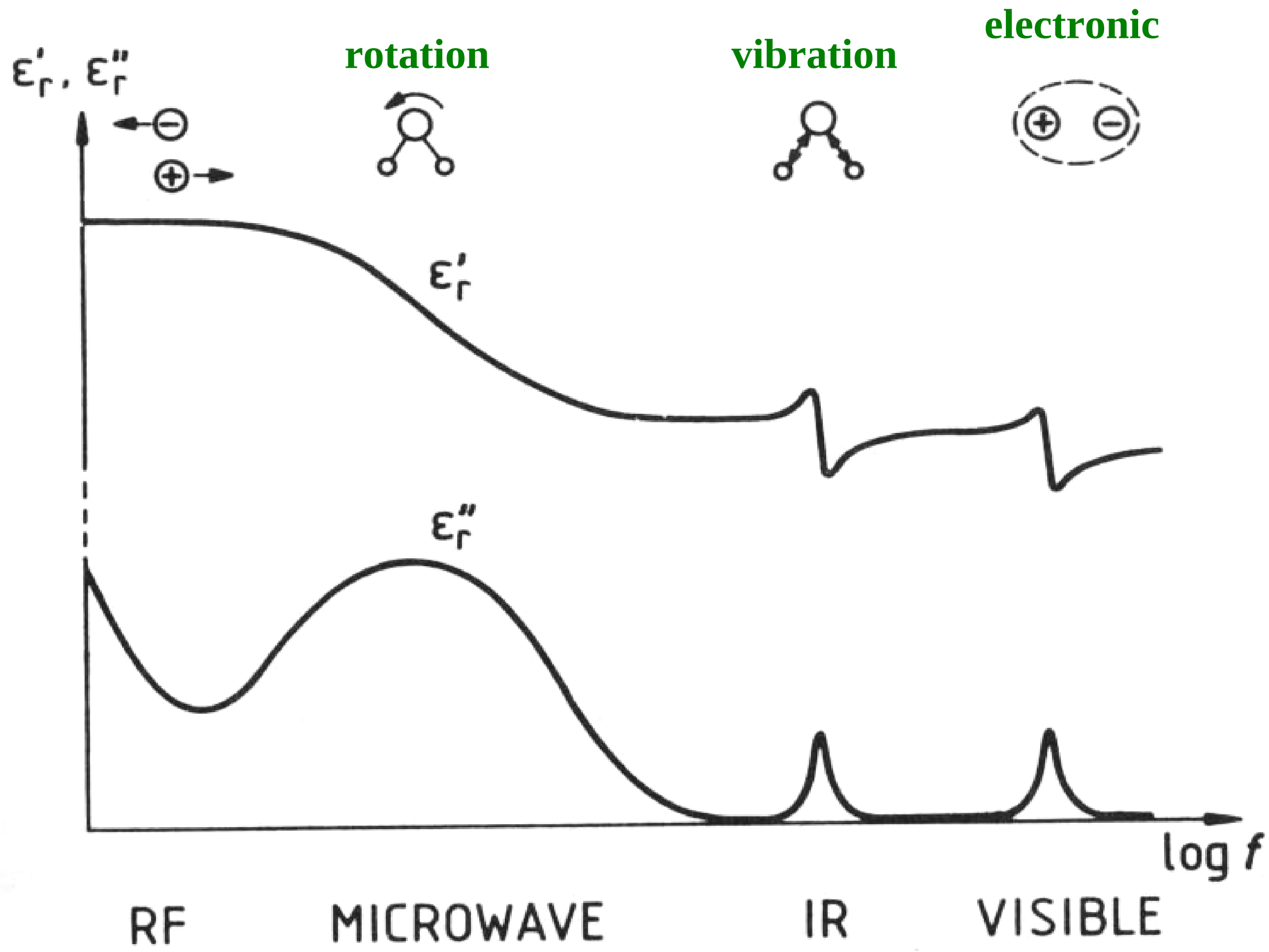
## Latent heat (melting):

- ice-water 333 J/g

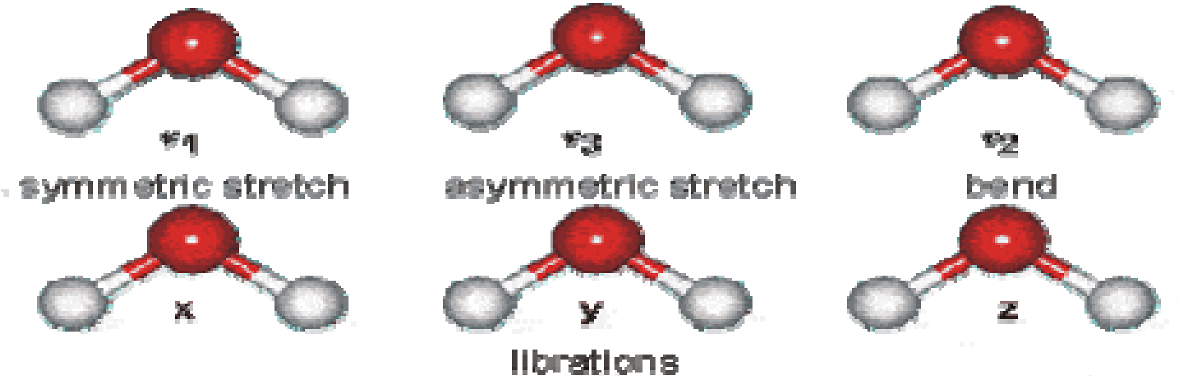


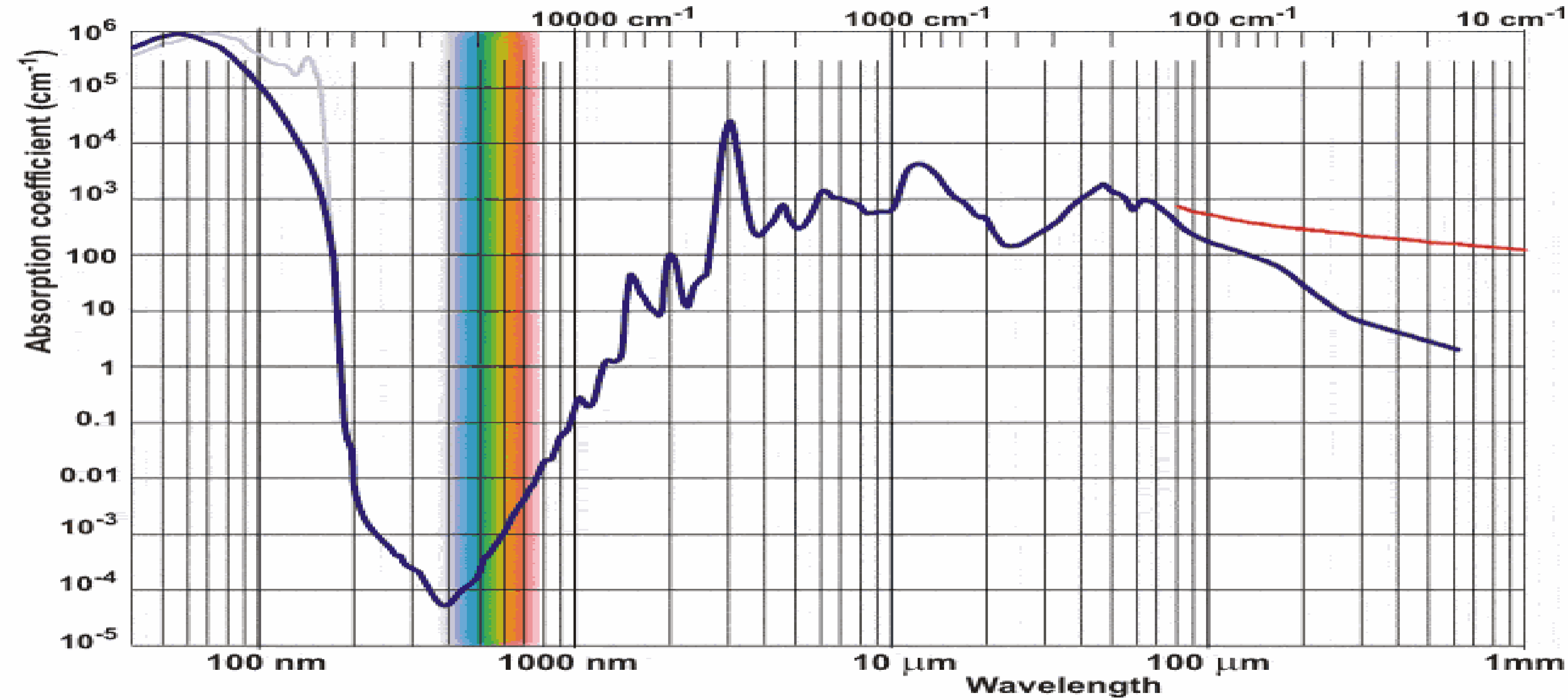
# Electromagnetic response

conductive dielectric

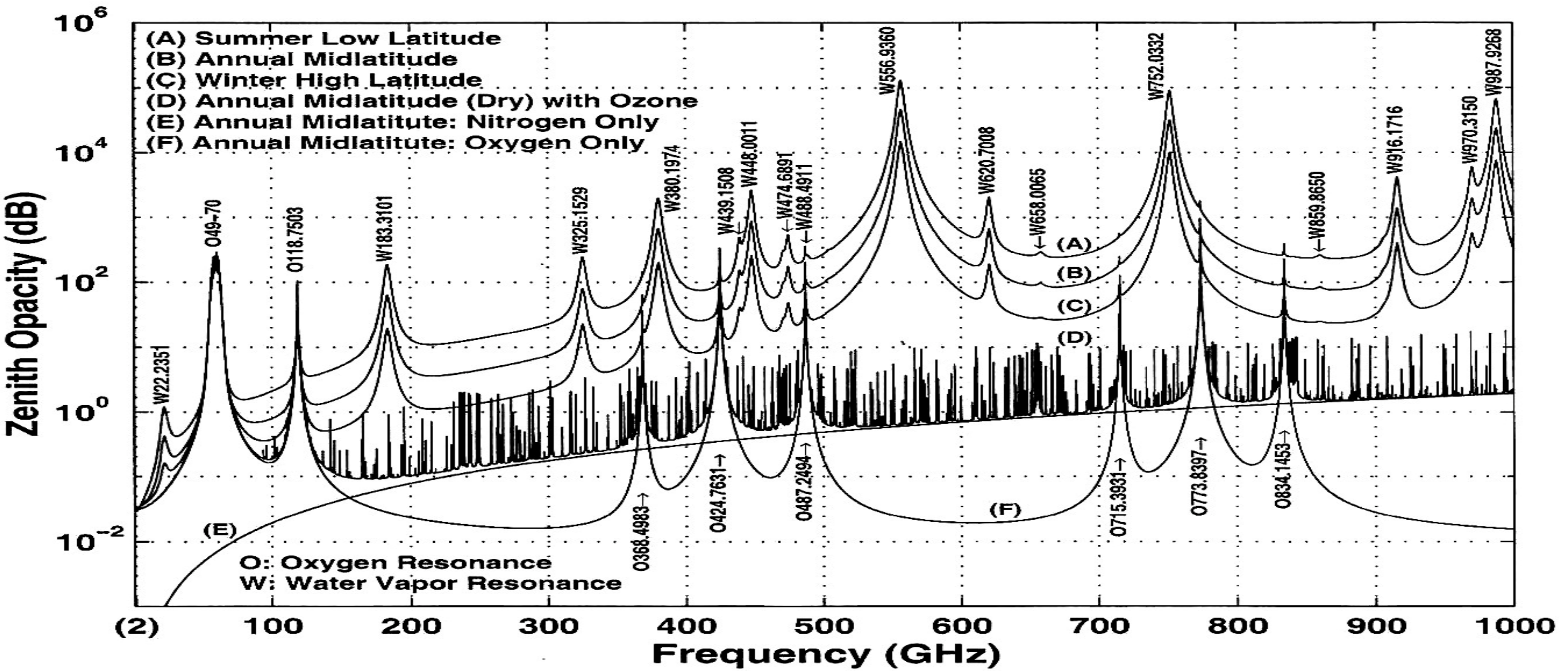



A qualitative presentation of parameters affecting the dielectric constant


ν1
symmetric stretch
ν3
asymmetric stretch
ν2
bend
x
y
z
librations


10000 cm-1
1000 cm-1
100 cm-1
10 cm-1
Absorption coefficient (cm-1)
10^6
10^5
10^4
10^3
100
10
1
0.1
0.01
10^-3
10^-4
10^-5
100 nm
1000 nm
10 µm
100 µm
1mm
Wavelength

# Atmospheric Microwave Absorption

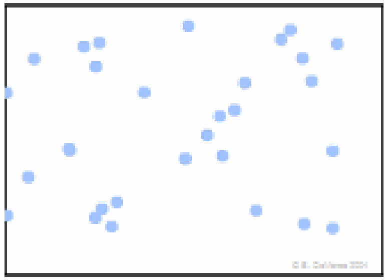



*Janssen M. A., 1993: Atmospheric remote sensing by microwave radiometry, Chapter 2, John Wiley &Son inc*

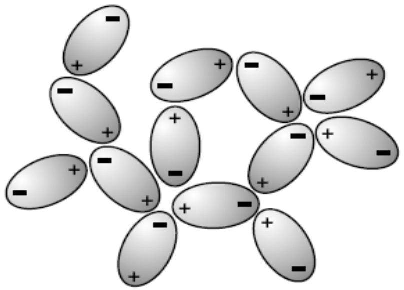
1. Rotational transition line: O3,H2O,CO,ClO, N2O…
2. Spin-rotational transition: O2 and zeeman splitting in upper atmosphere where geomagnetic field is important
3. Doppler and pressure broading

# Water em spectrum

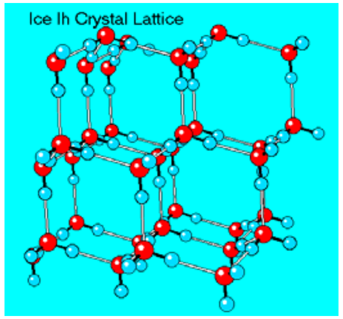
- **gas:**
  - spectral lines narrow but broadened with pressure



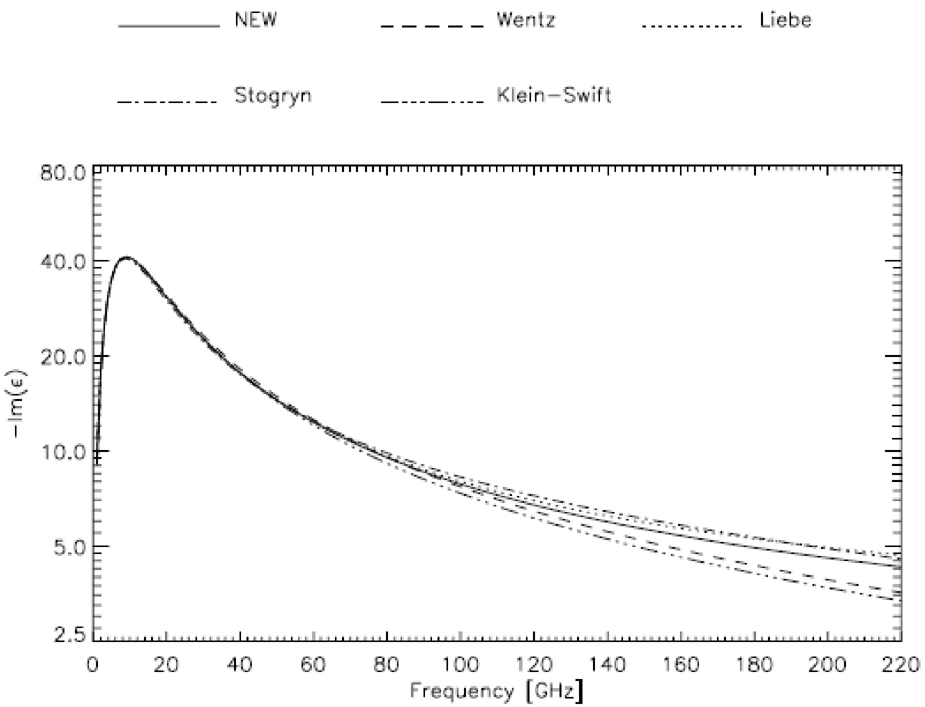
- **liquid:**
  - no lines, wide bands
  - pure water not conductive
  - saline water conductive (low frequency absorber)



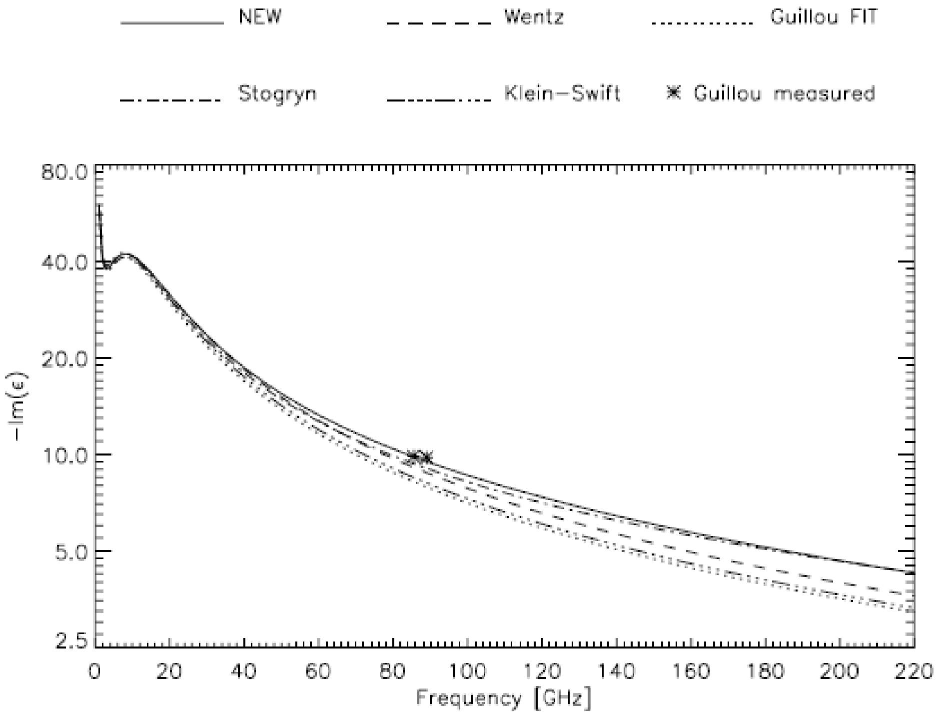
- **solid:**
  - absorber at low frequency only
  - conduction and large structure rotational transitions



# Microwave spectrum of water

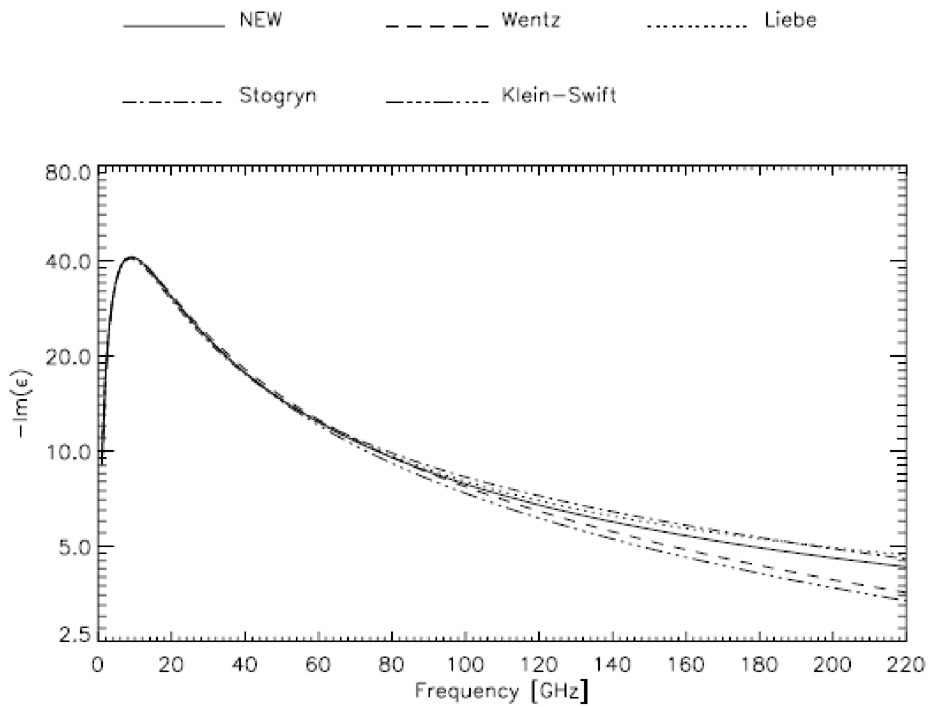



Pure water

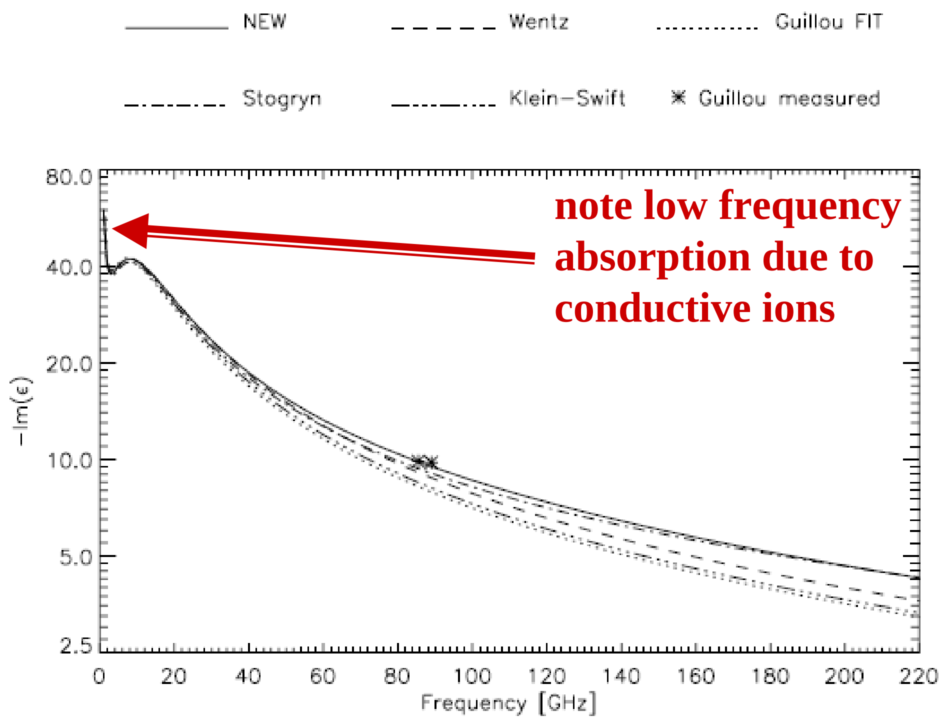



Sea water

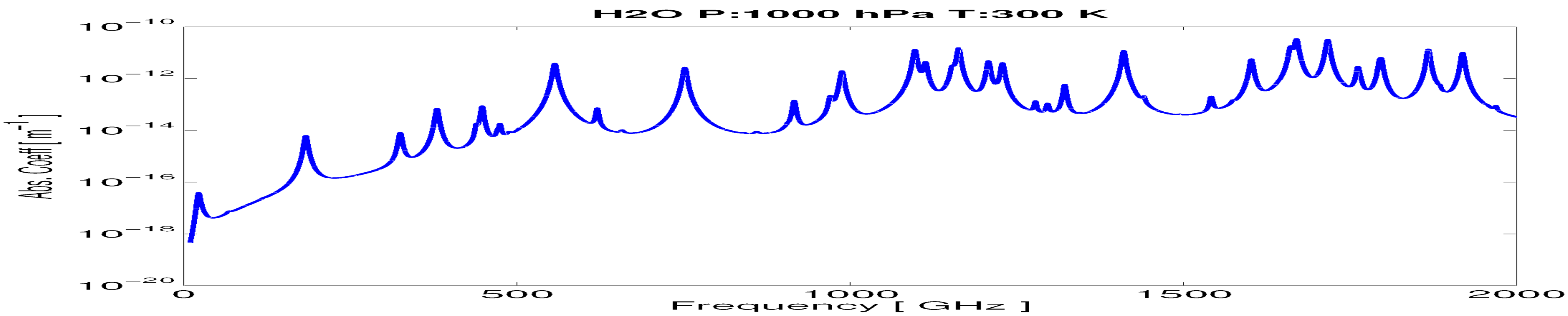
# Microwave spectrum of water

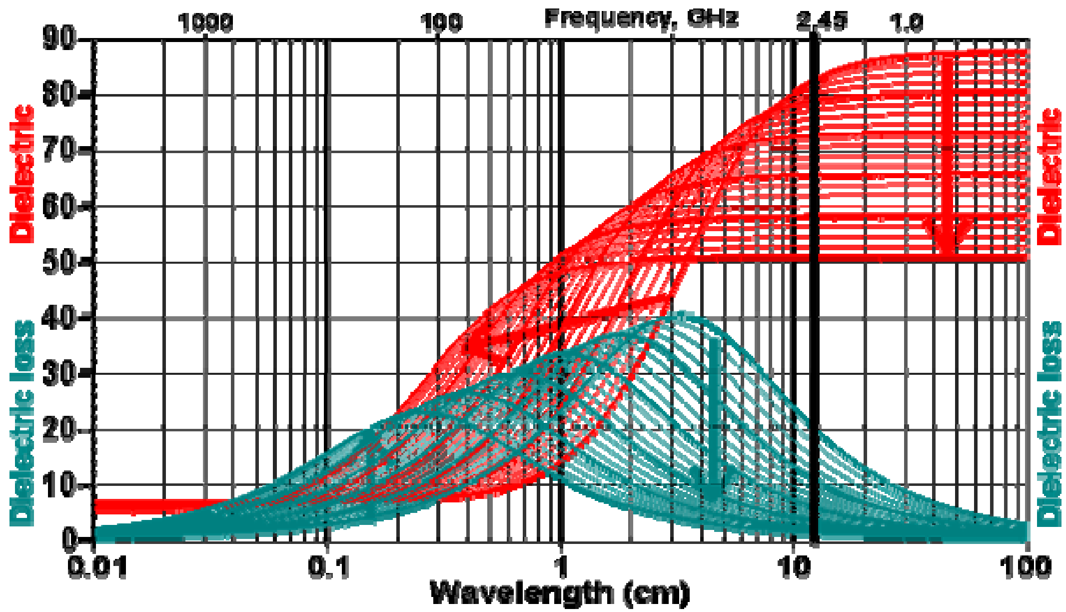


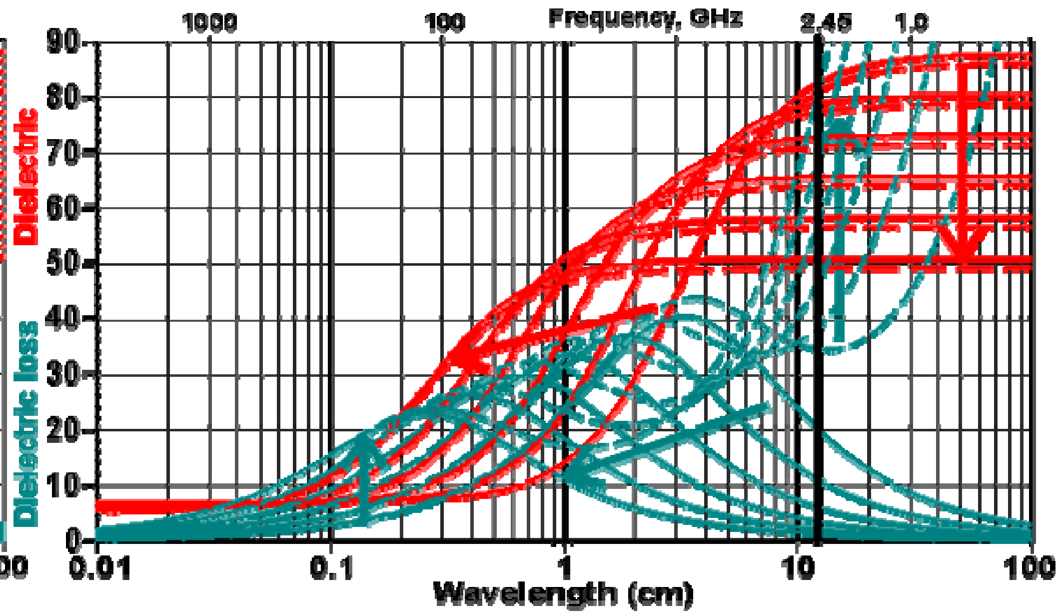

Pure water




Sea water




**pure water**

arrows increasing temperature

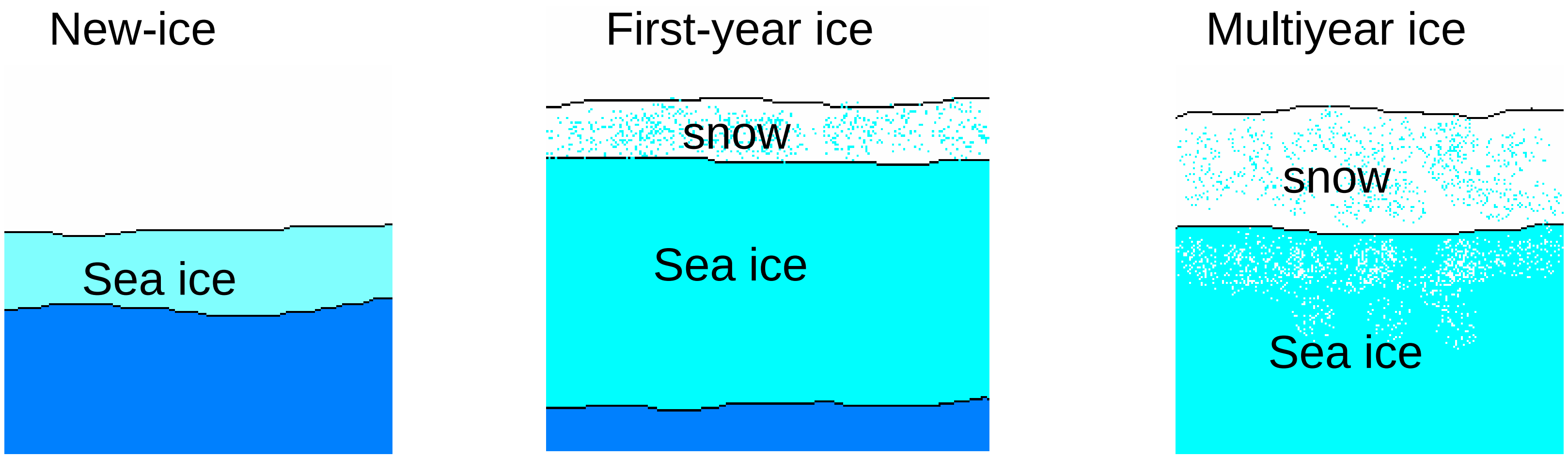
**saline water**

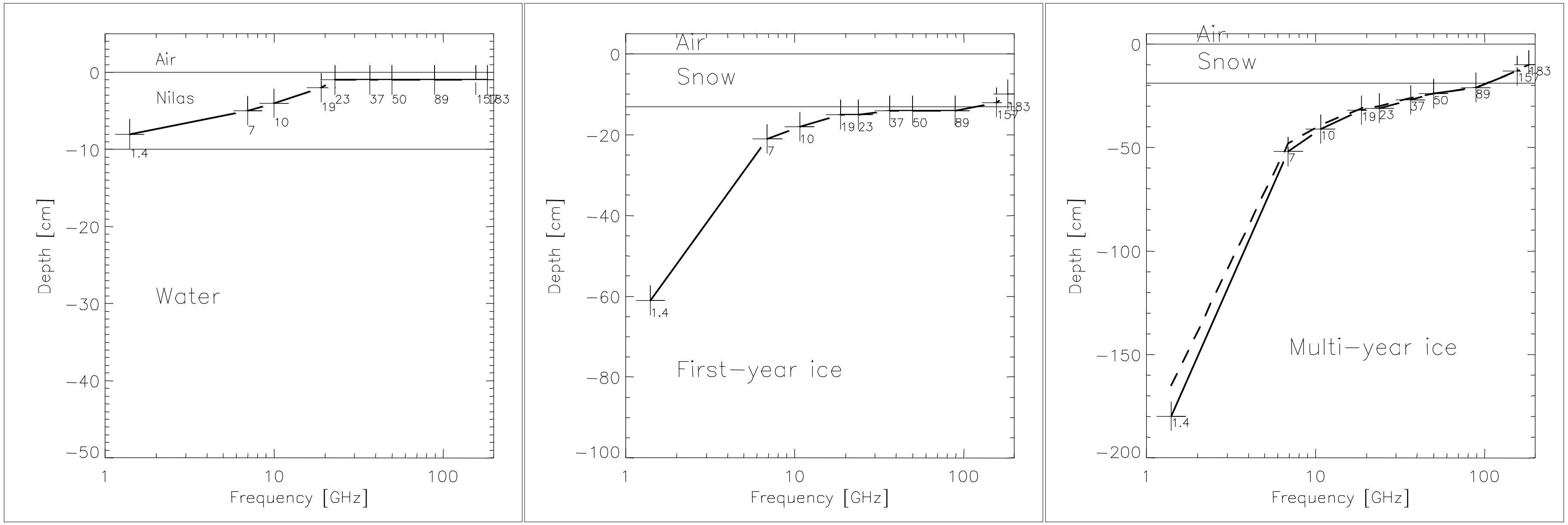
arrows increasing salinity

From http://www.lstu.ac.uk

# Penetration depth sea ice modelling

**From Sea-ice emission modelling: Tonboe et al. DMI/DTU 2006**



# Melting of ice → lessons:

- 333 J/g - to melt ice = 92 Wh/kg
- 4 J/g/°C - to heat water

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  > ice is best melted at < 100 MHz
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- **Water is different as solid (ice) and liquid (supercooled water)**

→ **possibly no single solution:**
  > low frequency (< 100 MHz) for ice temp < -10 °C
  > higher frequency for supercooled water -10 – 0 °C