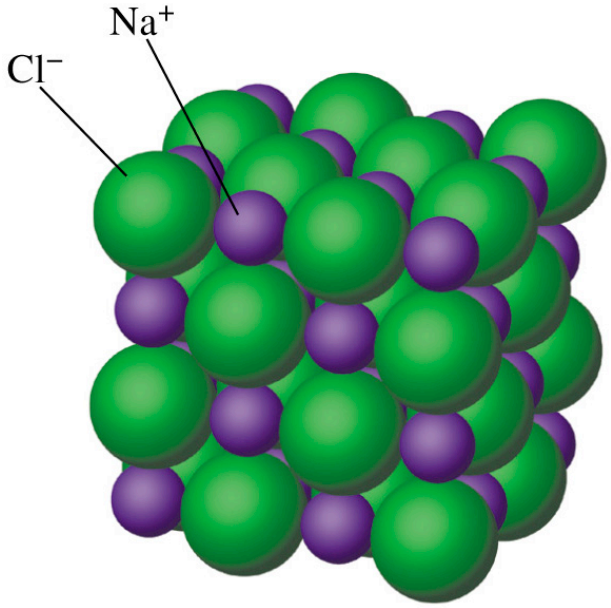
Molten Salts and Ionic Liquids

RWF Chemistry H2A

Normally we think of Sodium Chloride as a Solid:

Melting Point: 801 C
Boiling Point: 1465 C
Lattice: fcc
Lattice Parameter a = 564 pm



Normally we think of Sodium Chloride as a Solid:

Actually LiF/BeF_2

Melting Point: 801 C
Boiling Point: 1465 C

But it WILL form a liquid at high Temperature (>800C) and high Pressure.

"Molten Salts" are compounds that are ionic solids at room temperature and liquid at elevated temperatures.

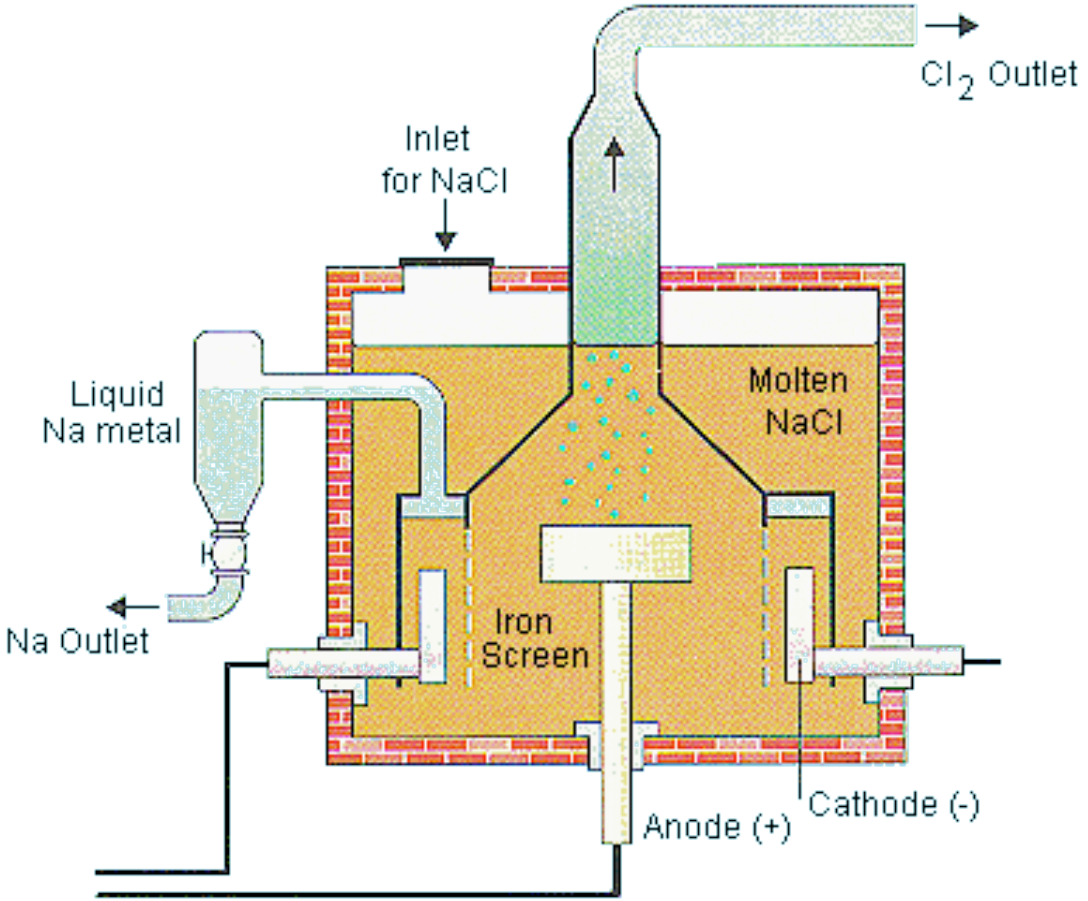
Useful Properties of Molten Salts

Actually LiF/BeF_2

- High Heat Capacity
- Conductive
- Very Low Vapor Pressure

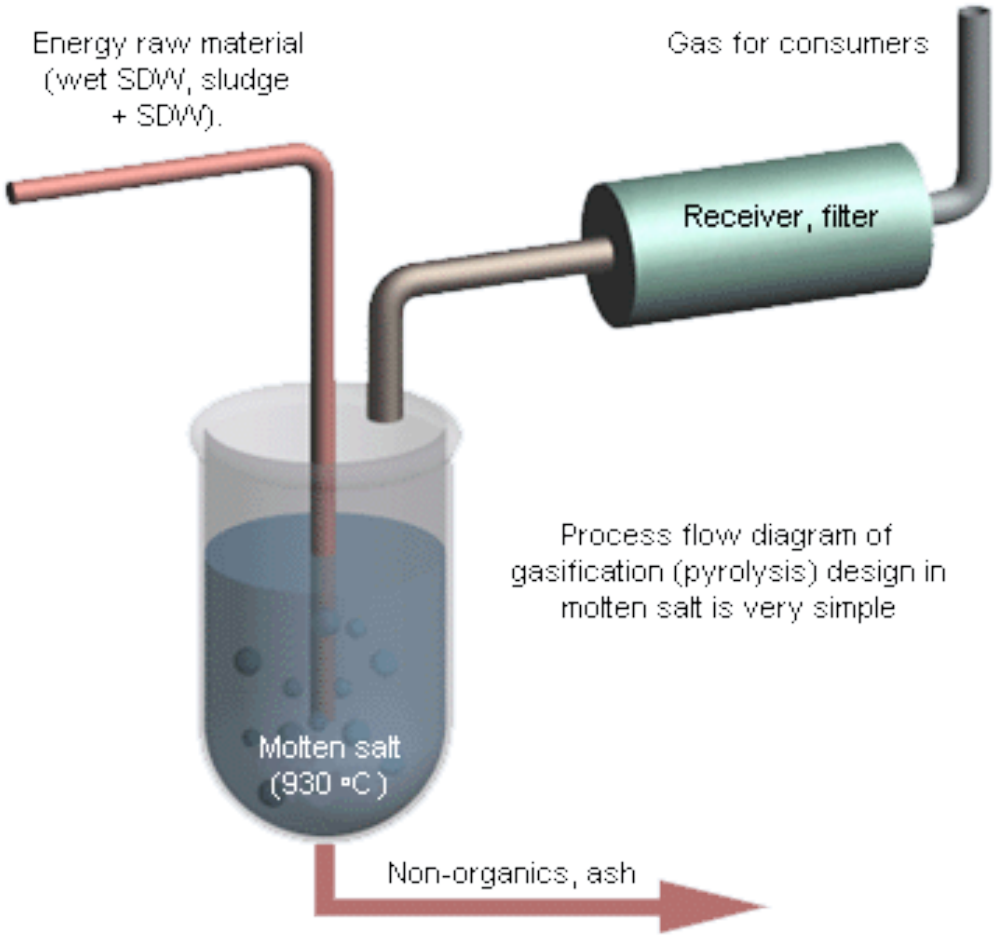
Many Applications

Molten Salt Application:



NaCl electrolysis for Na and Cl_2

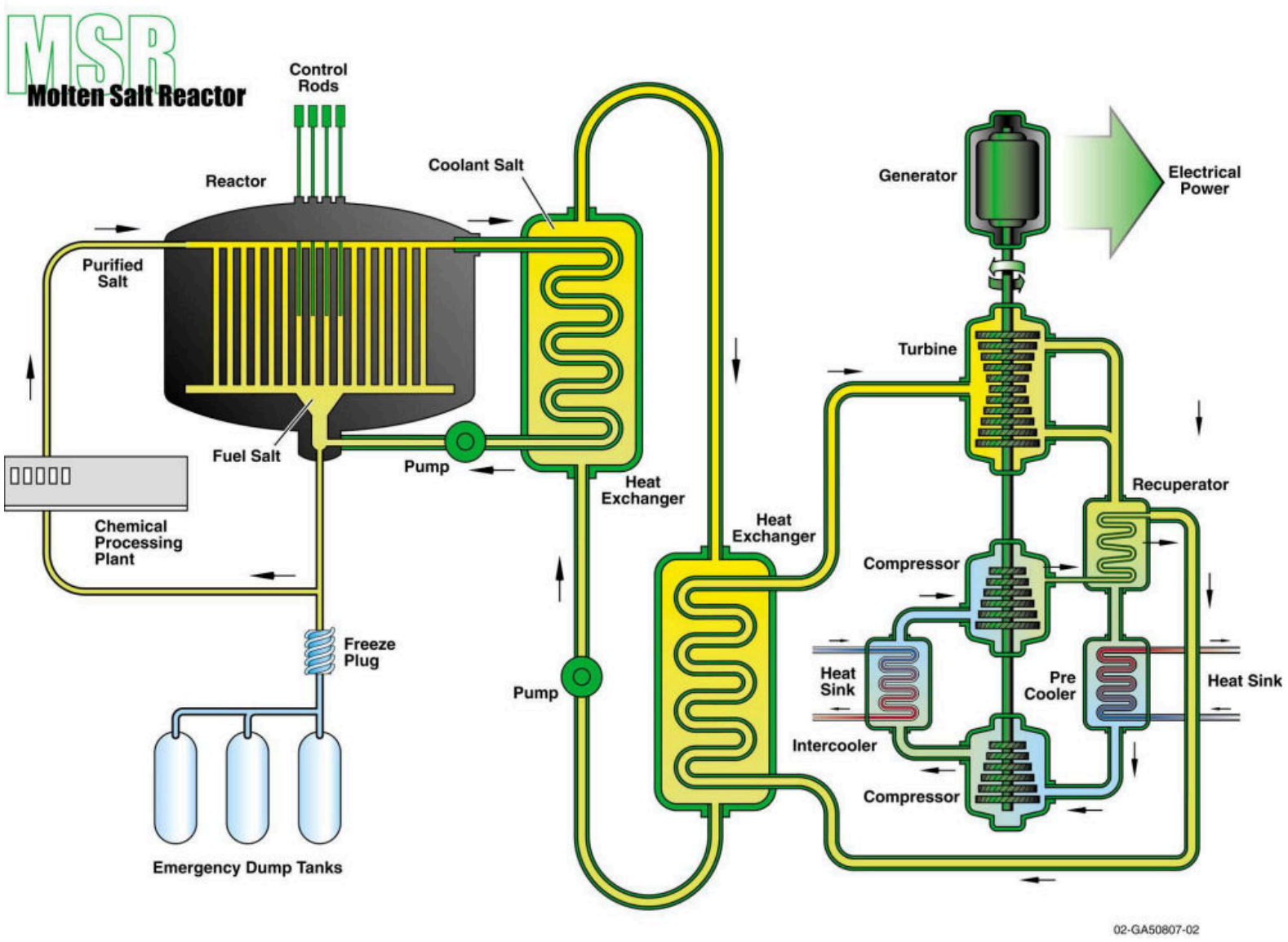
Molten Salt Application:



Process flow diagram of gasification (pyrolysis) design in molten salt is very simple

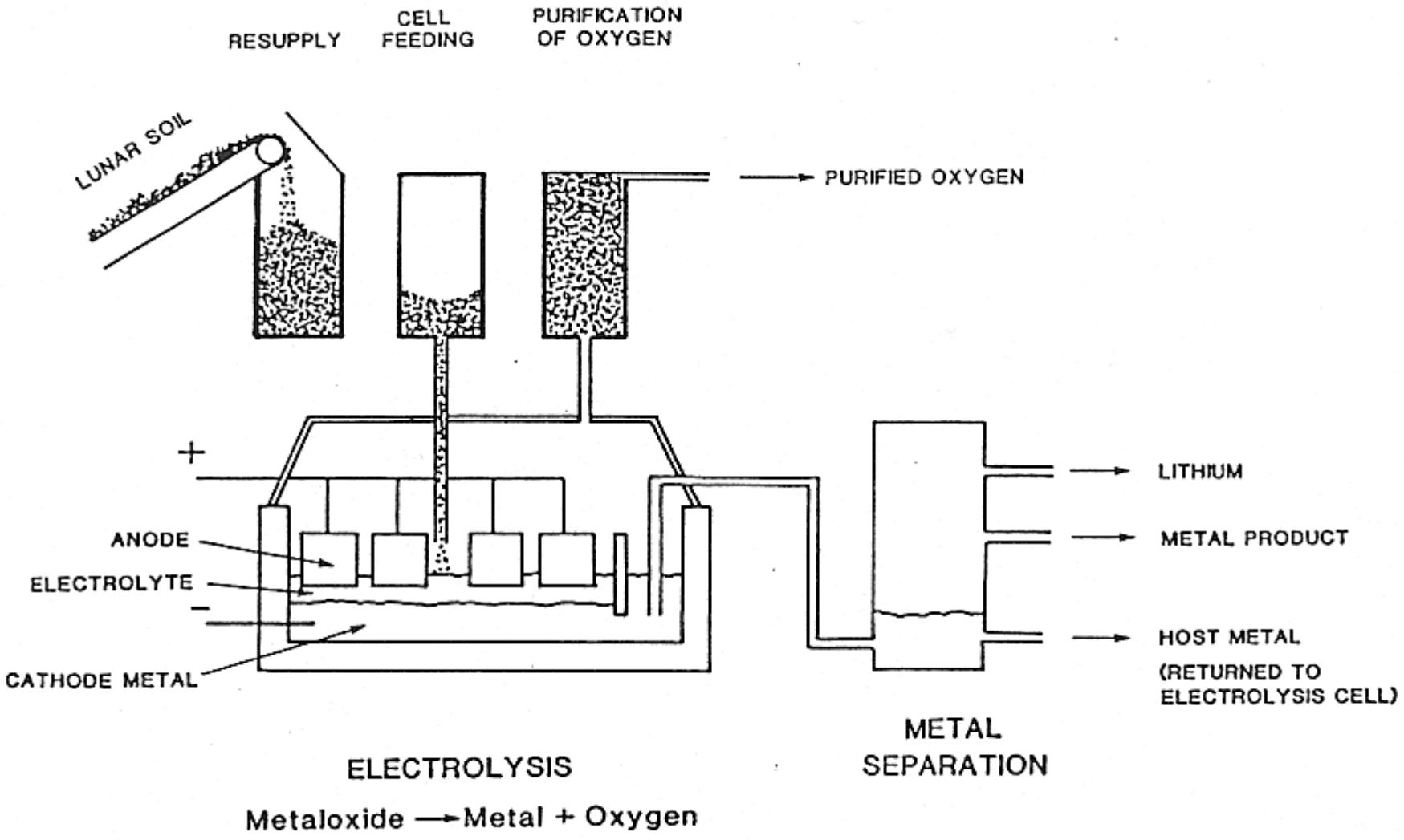
Waste Processing

Molten Salt Application:



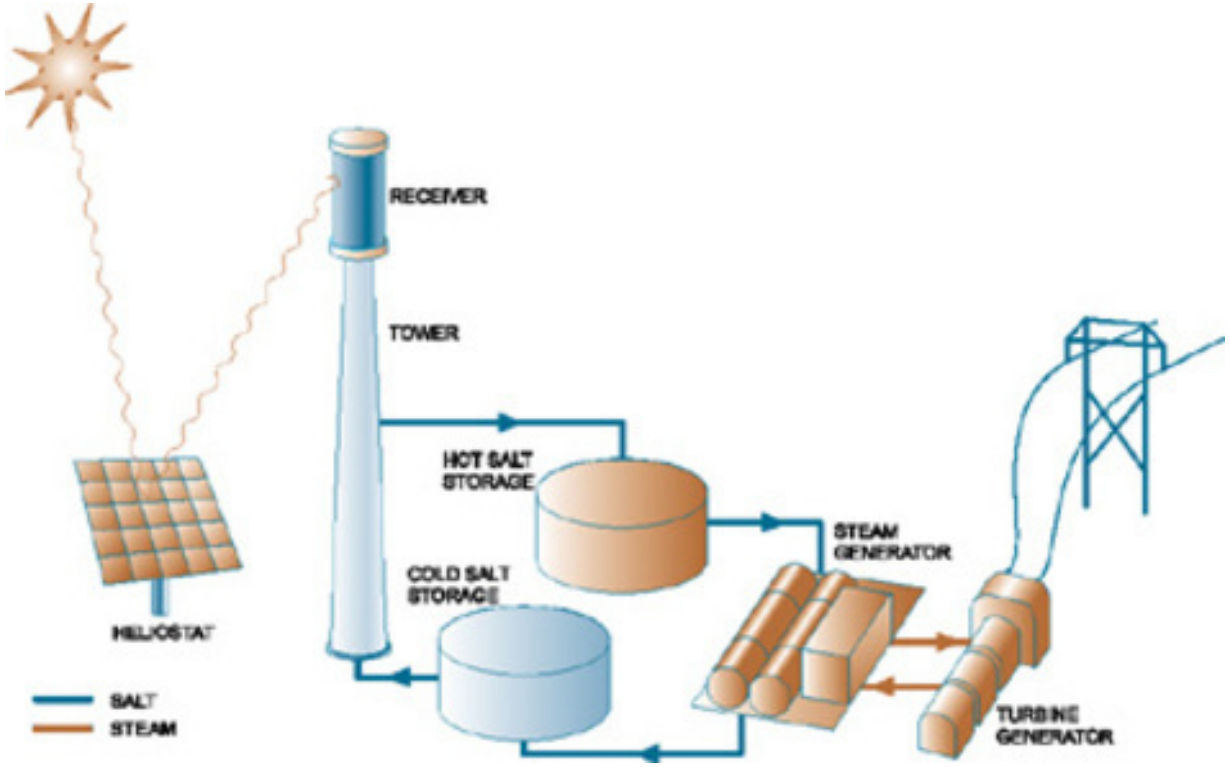
Nuclear Energy -- Thorium Fluoride Molten Salts

Molten Salt Application:



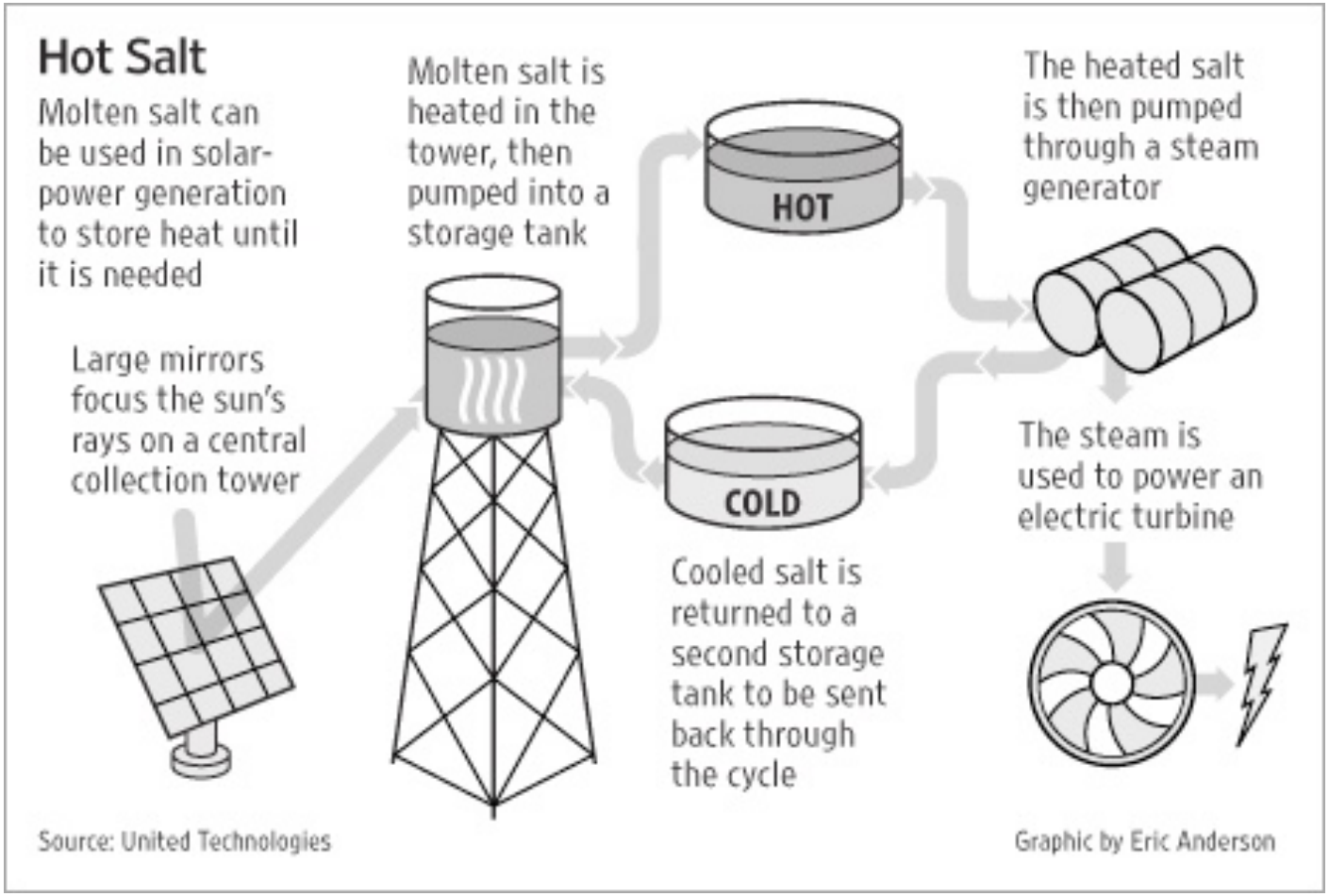
Lunar oxygen generation?

Molten Salt Application:



Solar Energy Applications

Molten Salt Application:



Solar Energy

Molten Salt Application:

Solar Energy Direct Salt Heating

Molten Salt Application:

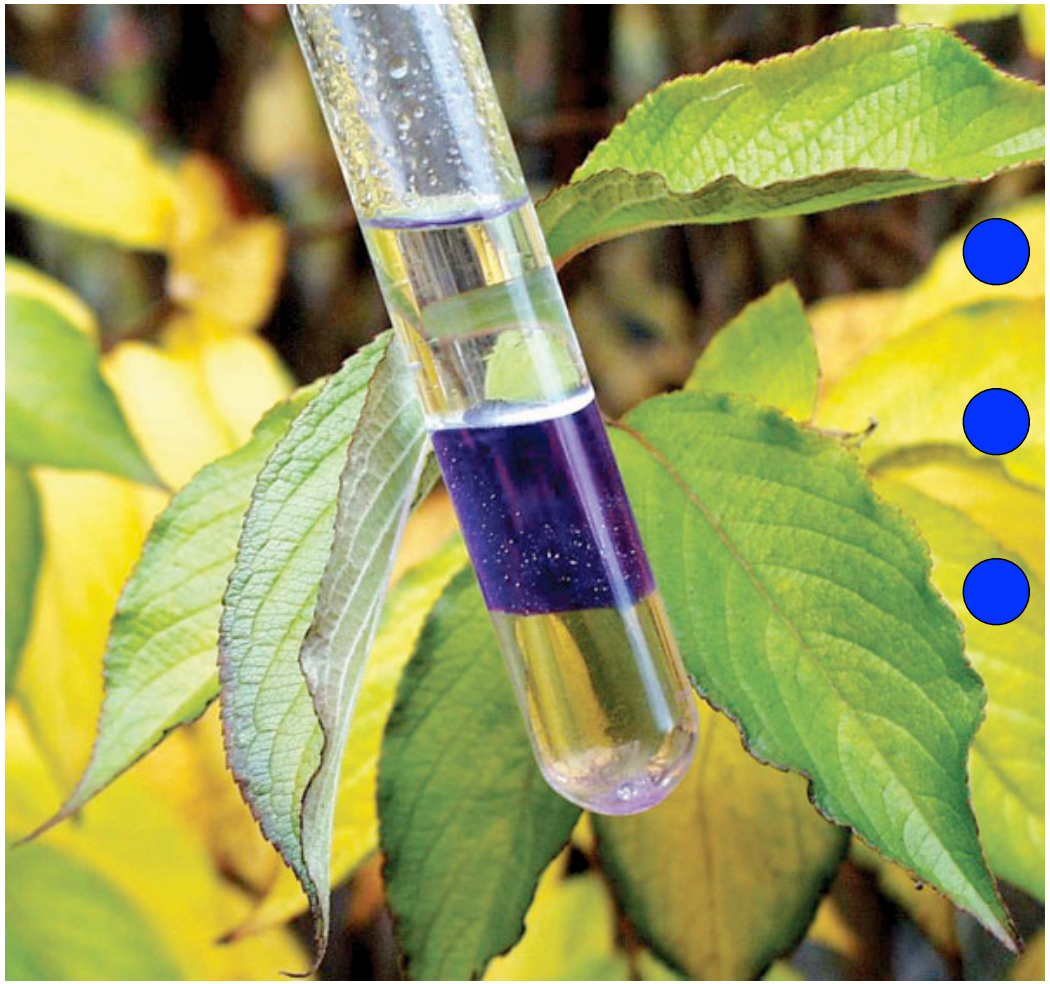
Solar Energy at Night

Room Temperature Ionic Liquids (RTILS)

"Ionic Liquids" are ionic compounds that are liquid at temperatures under 100 C.

"Green Chemistry"

Room Temperature Ionic Liquids (RTILS)

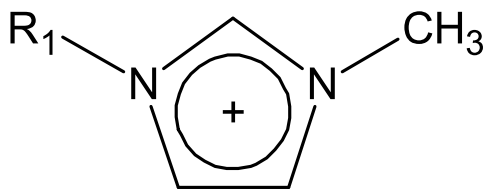


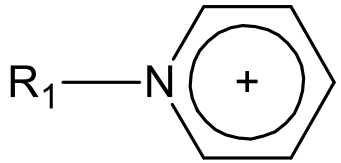
- Good Solvent
- Conductive
- Very Low Vapor Pressure

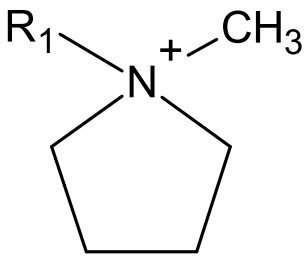
Many Applications

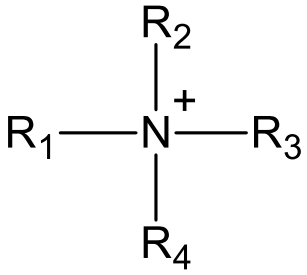
Ions frequently used for ILs

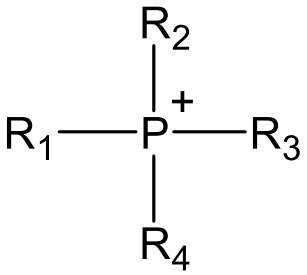
Cations





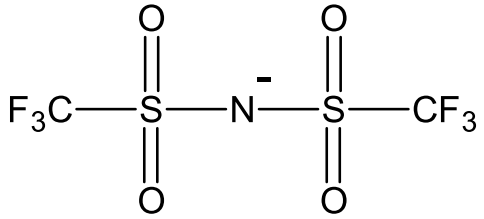


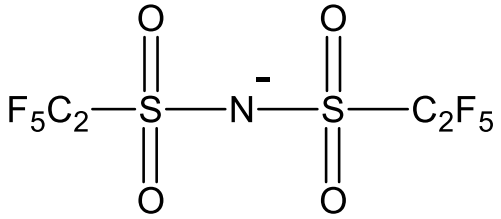




Anions

Cl^-, Br^-, I^-、$AlCl_4^-$ 、BF_4^- 、PF_6^-





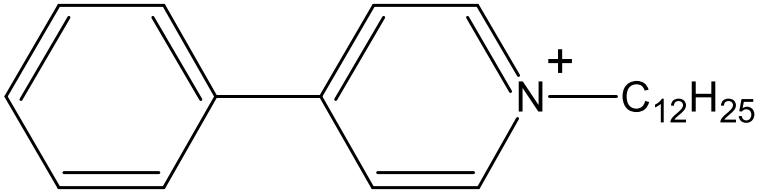
Characteristics of RTILs

- Liquid at wide temperature range — up to −100～400℃
- Negligibly low volatility — No odor. “Green” chemistry
- Low flammability — Safe (many exceptions)
- Reasonable ionic conductivity — 10^{-1} ～ 10^{-5} S cm^{-1}
- Stability（heat, chemical, electrochemical）
- Solvation environment different from that in molecular solvents

A typical ionic liquid

1-Dodecyl-4-phenylpyridinium

$C_{12}PPy^{+}$



Bis(perfluoroethylsulfonyl)imide

$C_2C_2N^{-}$

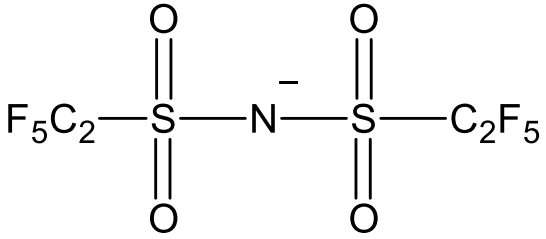
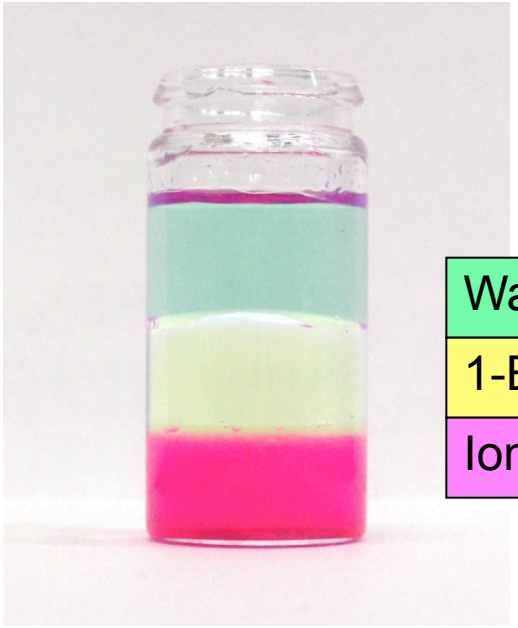


Table. Physicochemical properties for water-saturated $[C_{12}PPy][C_2C_2N]$.

T_g (°C)	d [b] (g cm^{-3})	η [b] (mPa s)	κ [b] (μS cm^{-1})	$S_{R/W}$ [b] (mol dm^{-3})	$S_{W/R}$ [b] (wt%)
−57 [a]	1.209	529	77.9	2×10^{-5}	0.36

[a] Melting point was not observed. [b] At 25˚C.

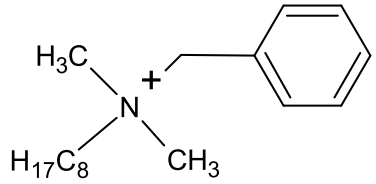
RTILs - The Third solvent

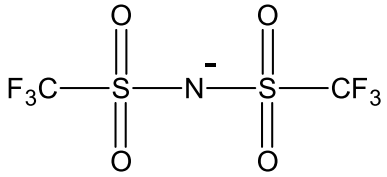


Water / $NiCl_2$

1-Bromodecane / Perylene

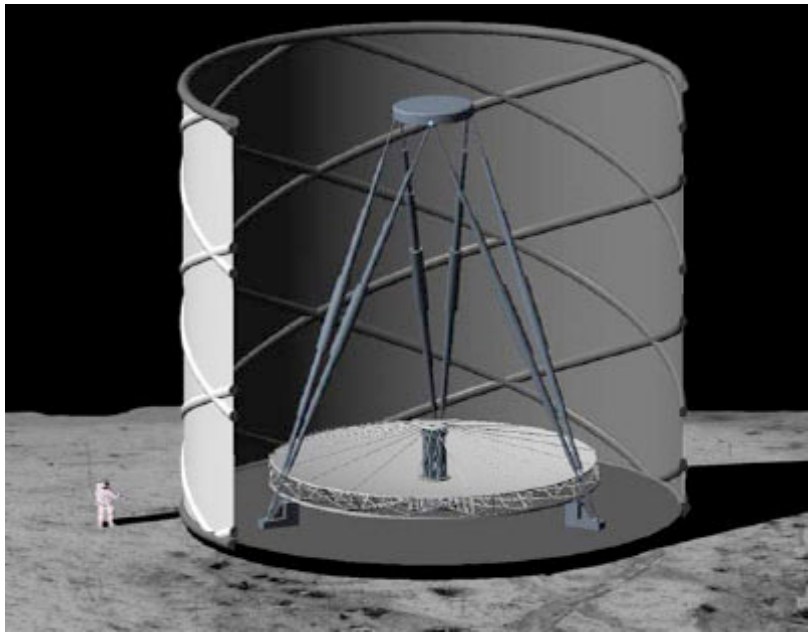
Ionic liquid / Rose bengal



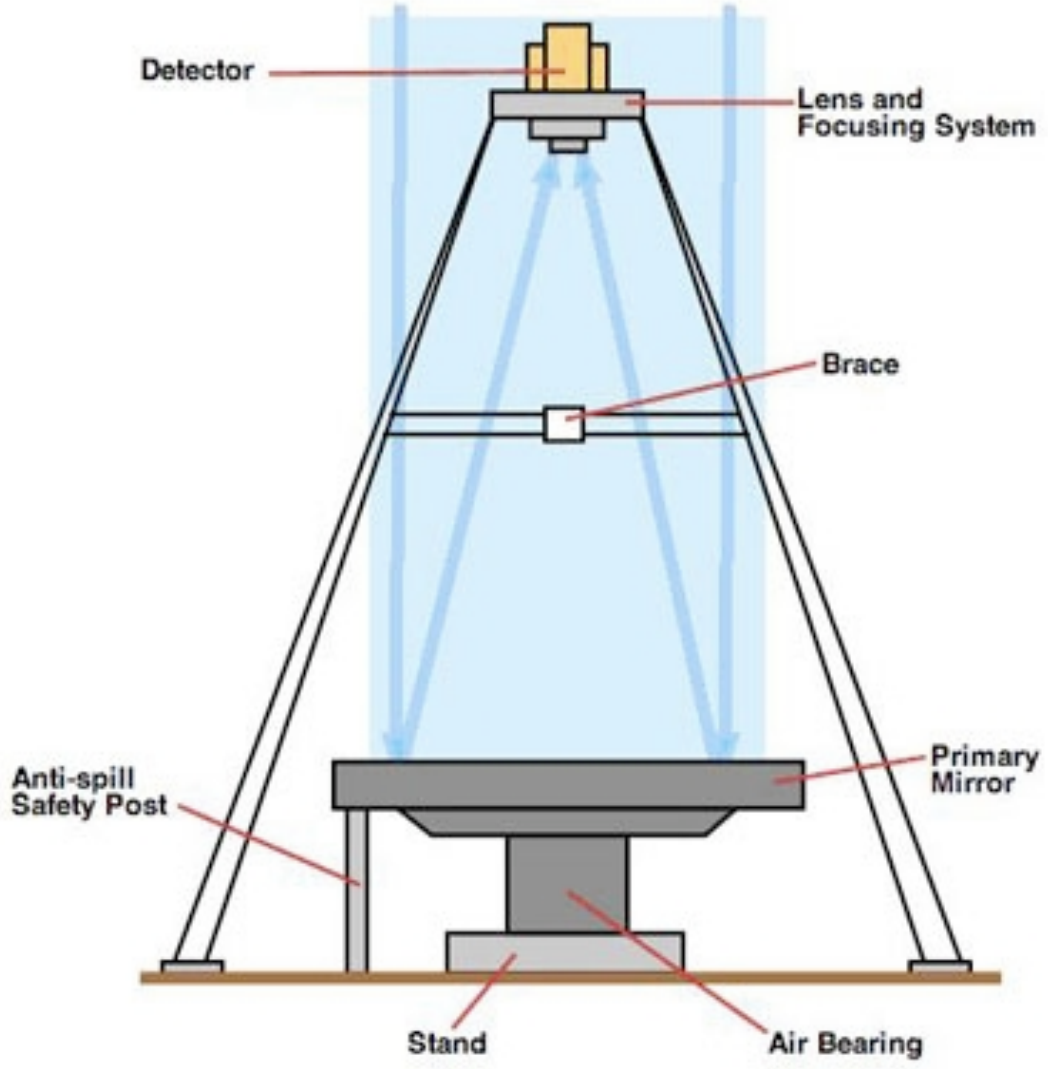


Can be immiscible with both water and organic solvents

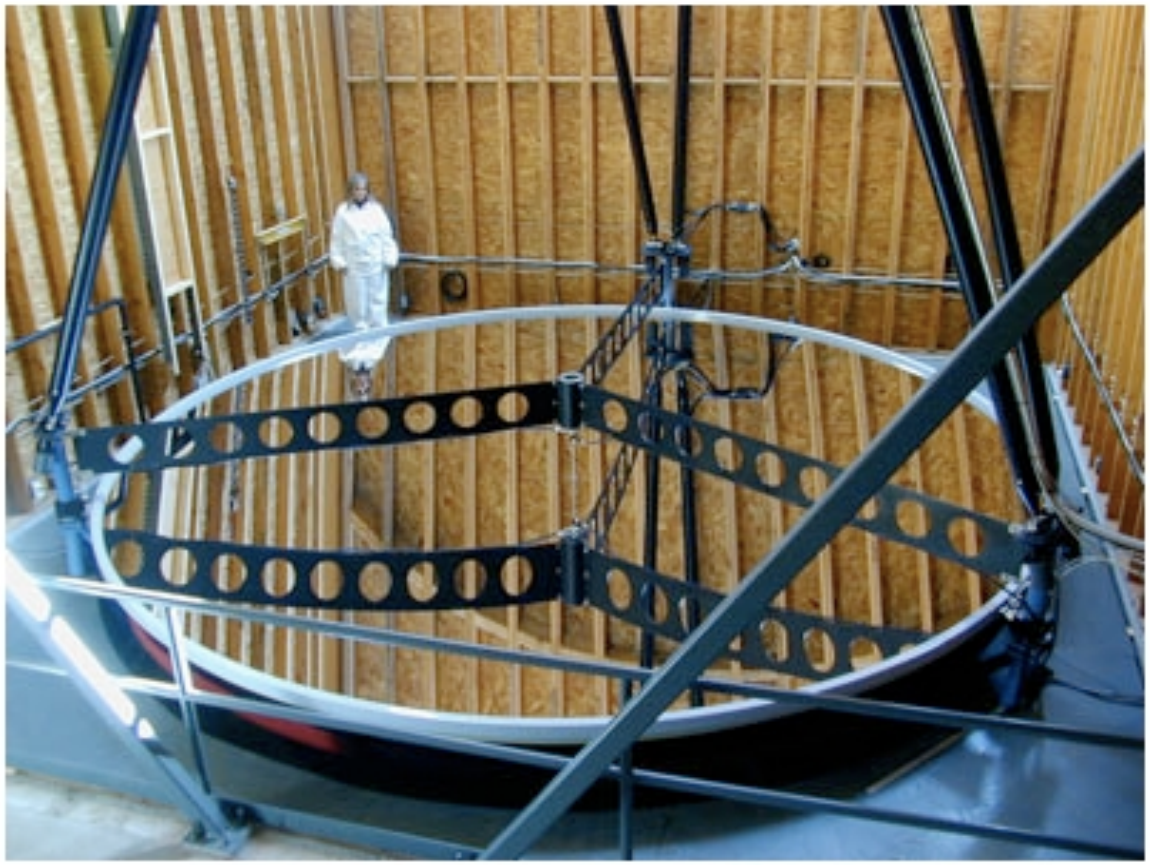
Liquid Mirror Telescopes!



Liquid Mirror Telescopes!



Liquid Mirror Telescopes!



NASA/Photo by Paul Hickson (University of British Columbia)

The Large Zenith Telescope

Liquid Mirror Telescopes!

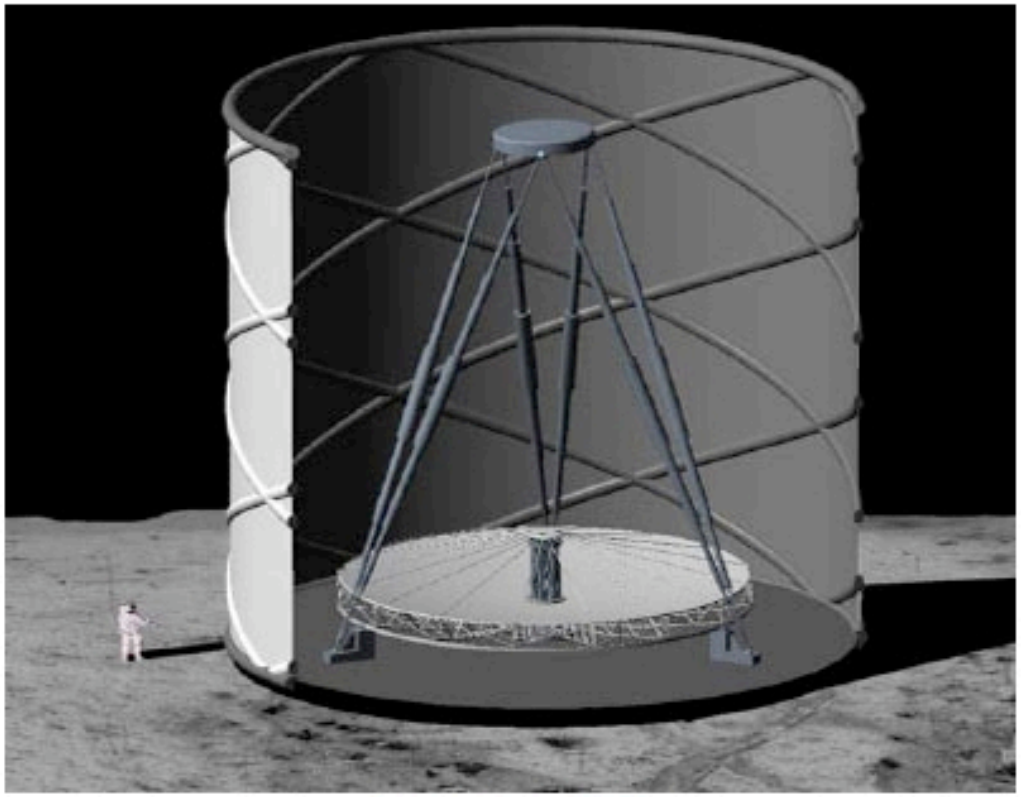


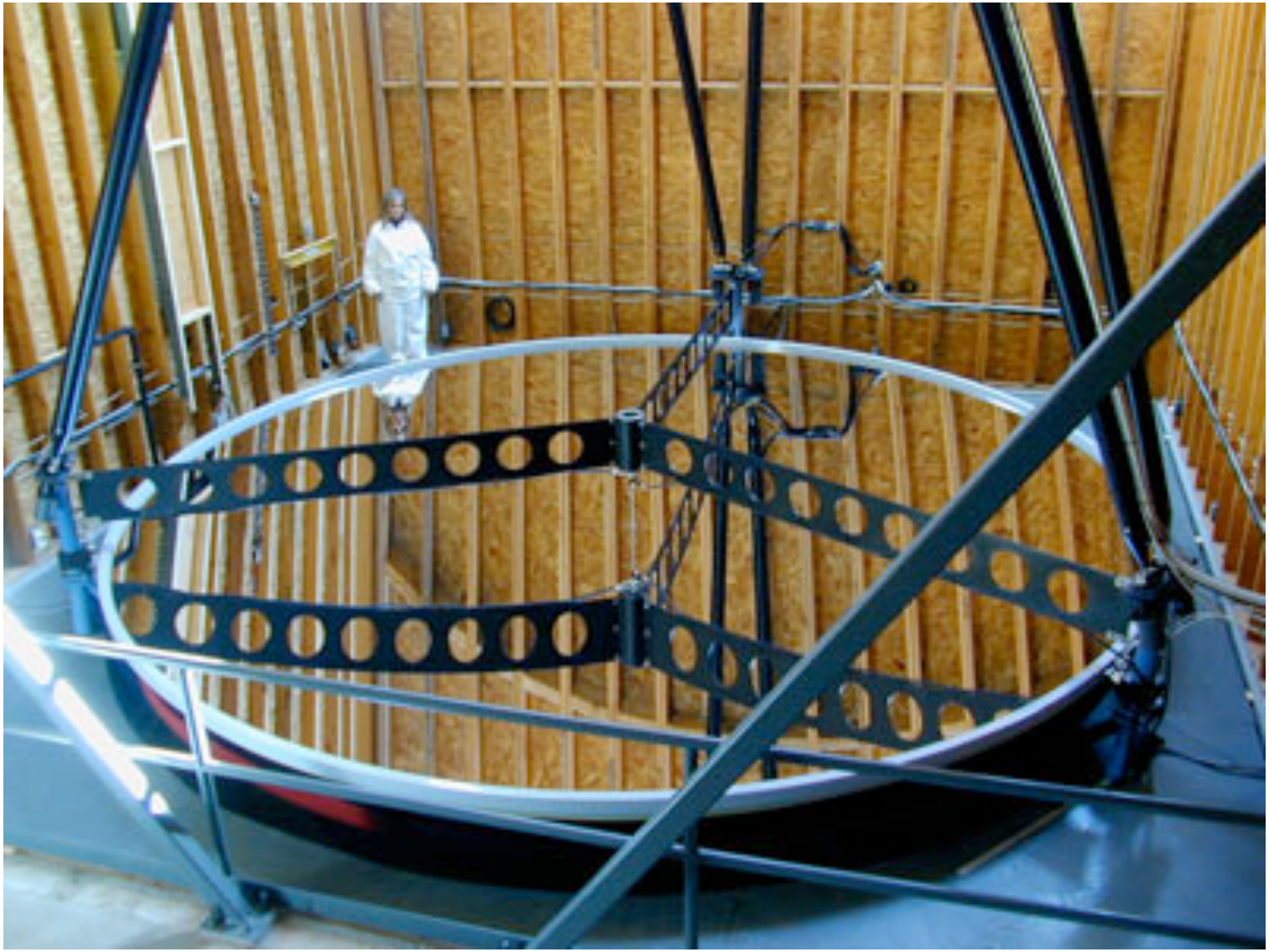
Image courtesy of NASA

A NASA rendering of a lunar liquid mirror telescope

Recently, scientists have discovered a class of liquids that might make an LLMT possible. They are known as **ionic fluids**, and they have these important properties:

- They are liquid at temperatures below -212° F (-136° C).
- They are composed entirely of ions.
- They possess no vapor pressure at room temperature or below, which means they won't evaporate.
- They are highly viscous.

Molten Salts and Ionic Liquids



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