

# Hydrogen/Deuterium exchanges in cometary and interstellar ice analogs

Mathilde Faure Thesis supervisors : Alexandre Faure, Eric Quirico Collaborators : Bernard Schmitt, Patrice Theulé











## **Experiment and method**



## Results : H/D exchanges



## Results : H/D exchanges



## Results : crystallization



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# Exchange vs crystallization



H/D exchange between water and amine (- $ND_2$ ) or hydroxyl (-OD) occurs in ice in less

than 1 year above 100K.

Thermal fractionation equilibrium between -ND<sub>2</sub> and -OD functional groups and water

H/D exchange, crystallization and desorption = similar timescales



Necessity to quantify each process relatively to each other to define the thermal evolution of ice.

#### Conclusion

H/D exchanges with water

- for CH<sub>3</sub>NH<sub>2</sub> and CH<sub>3</sub>OH
- not for HCN

D/H ratios in organics may represent that of water in thermally processed ices



Activation energy for H/D exchanges around 3500K

#### Thank you for your attention

 $HCN : D_2O$ 





Kinetic model ( <i>i</i> )	$f_i(\alpha)$	$g_i(\alpha)$
Avrami-Erofeev (A2)	$2(1-\alpha)[-\ln(1-\alpha)]^{1/2}$	$[-\ln(1-\alpha)]^{1/2}$
Avrami-Erofeev (A3)	$3(1-\alpha)[-\ln(1-\alpha)]^{2/3}$	$[-\ln(1-\alpha)]^{1/3}$
Avrami-Erofeev (A4)	$4(1-\alpha)[-\ln(1-\alpha)]^{3/4}$	$[-\ln(1-\alpha)]^{1/4}$
First <u>order</u> (01)	$(1-\alpha)$	$-\ln(1-\alpha)$
Second order (02)	$(1 - \alpha)^2$	$(1-\alpha)^{-1}-1$
Third order (03)	$(1 - \alpha)^3$	$[(1-\alpha)^{-2}-1]/2$



