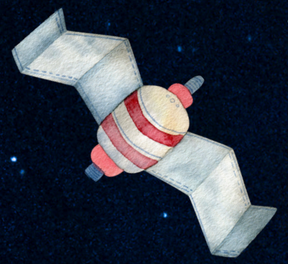
FIKUT NEXTGEN

Meeting of Young Astronomers and Astrophysicists - FIKUT NEXTGEN

IRRADIATION OF METHANOL ICES AS AN ANALOGUE FOR ASTROCHEMICAL PROCESSES



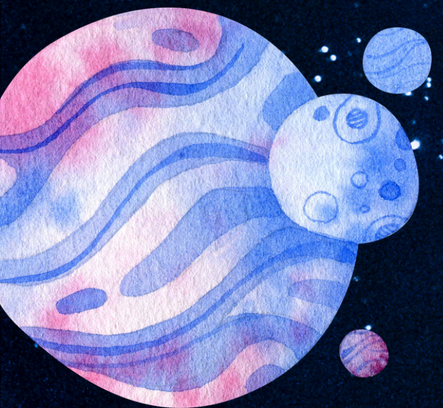
RODRIGO ZAMUDIO RAMIREZ

SUPERVISOR: PROFESSOR NIGEL MASON

UNIVERSITY OF DEBRECEN

HUN-REN INSTITUTE FOR NUCLEAR RESEARCH



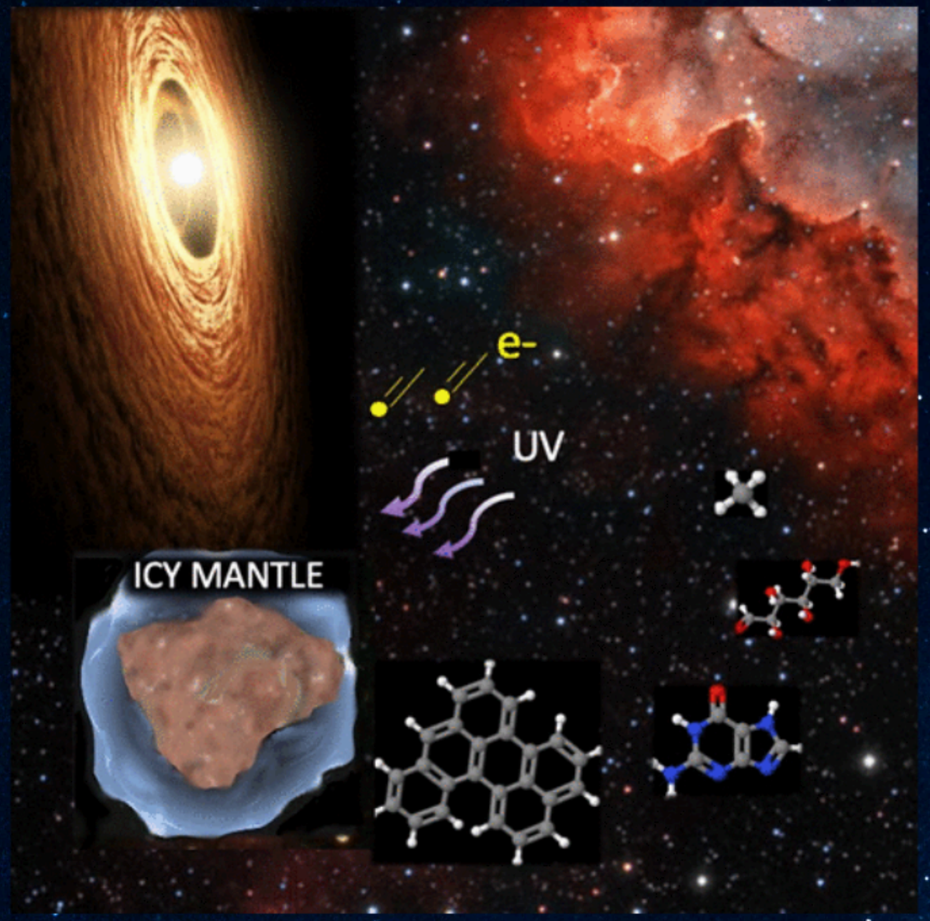




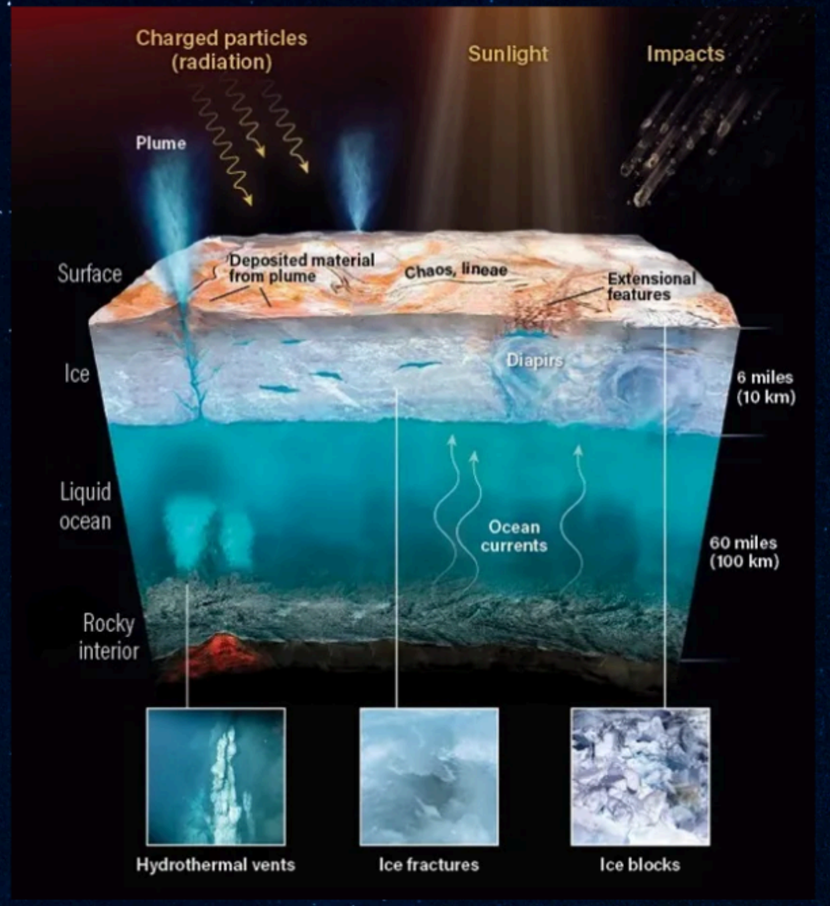
MEETING OF YOUNG ASTRONOMERS AND ASTROPHYSICISTS - FIKUT NEXTGEN

05/11/2026

WHERE CAN WE FIND THE EFFECTS OF ASTROCHEMISTRY?



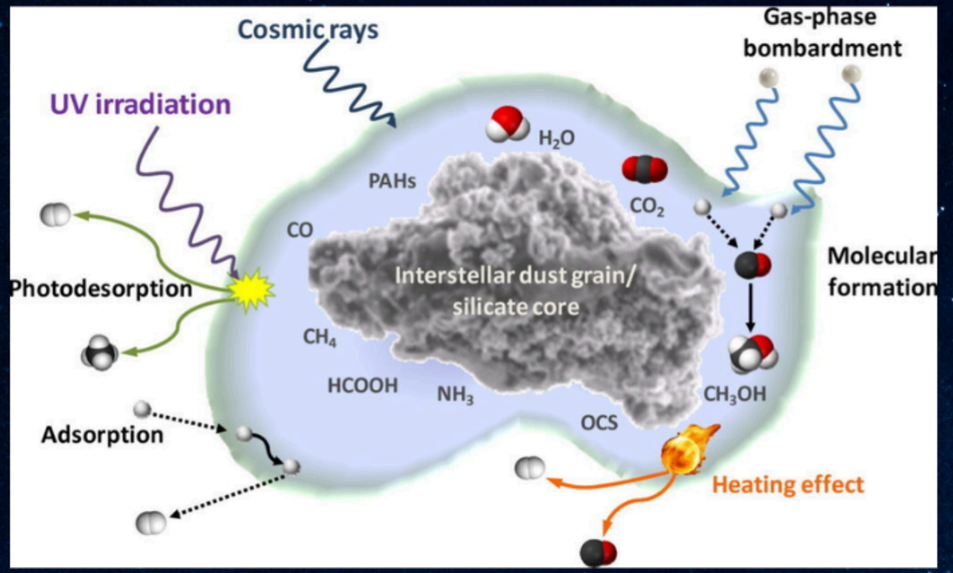
Interstellar medium



Planets, moons and their atmospheres

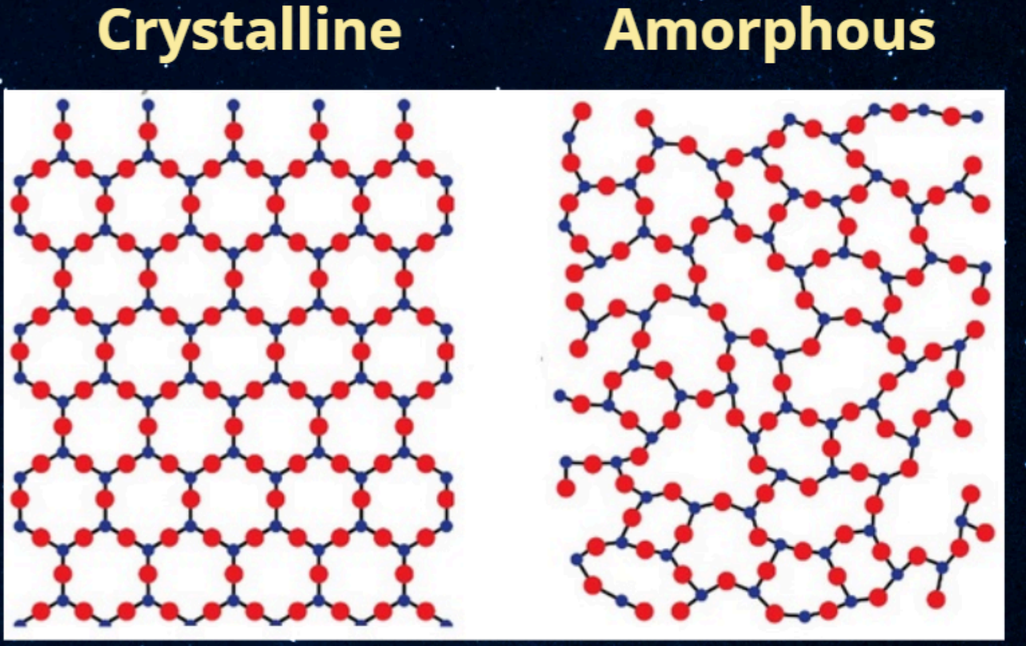
KEY QUESTIONS

1) How chemical synthesis takes place in astrophysical ices?



Irradiation of ices of different compositions. Credit: Sivaraman et al., 2020.

2) How physical changes are produced in crystalline ices?



HOW CAN WE STUDY THESE PROCESSES?





IN-SITU EXPLORATION



COMPUTATIONAL SIMULATIONS



LABORATORY



Experiment



Energy

Crystalline

T_{dep} = 130 K

T_{irr} = 20 K

Amorphous

T_{dep} = 20 K

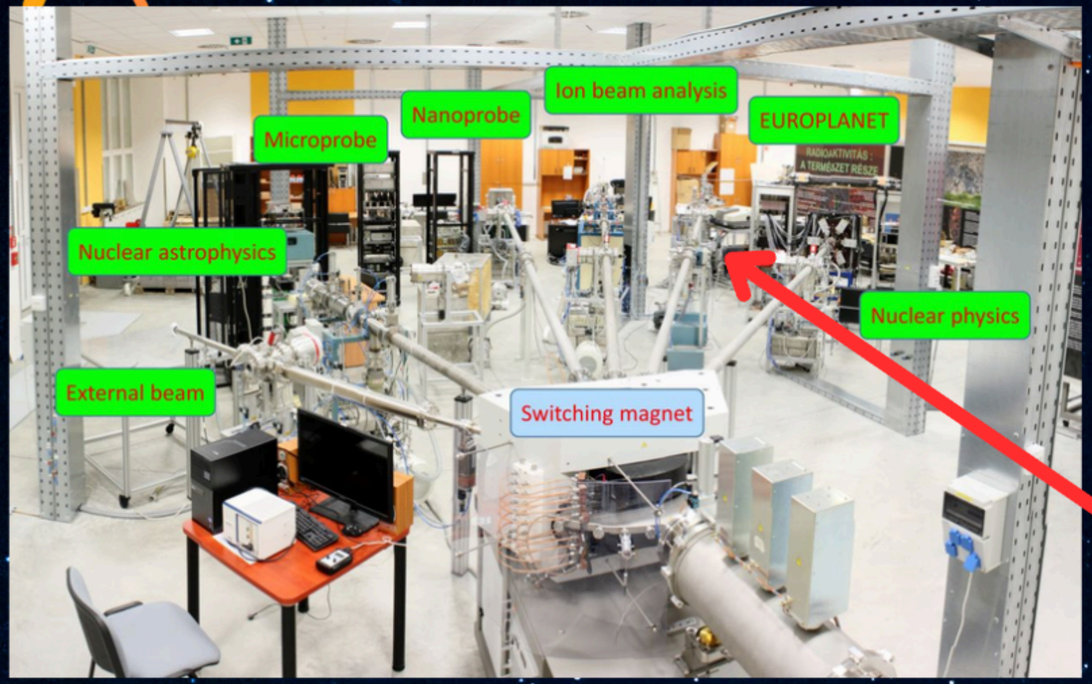
T_{irr} = 20 K



250 keV, 500 keV, 750 keV and 1MeV



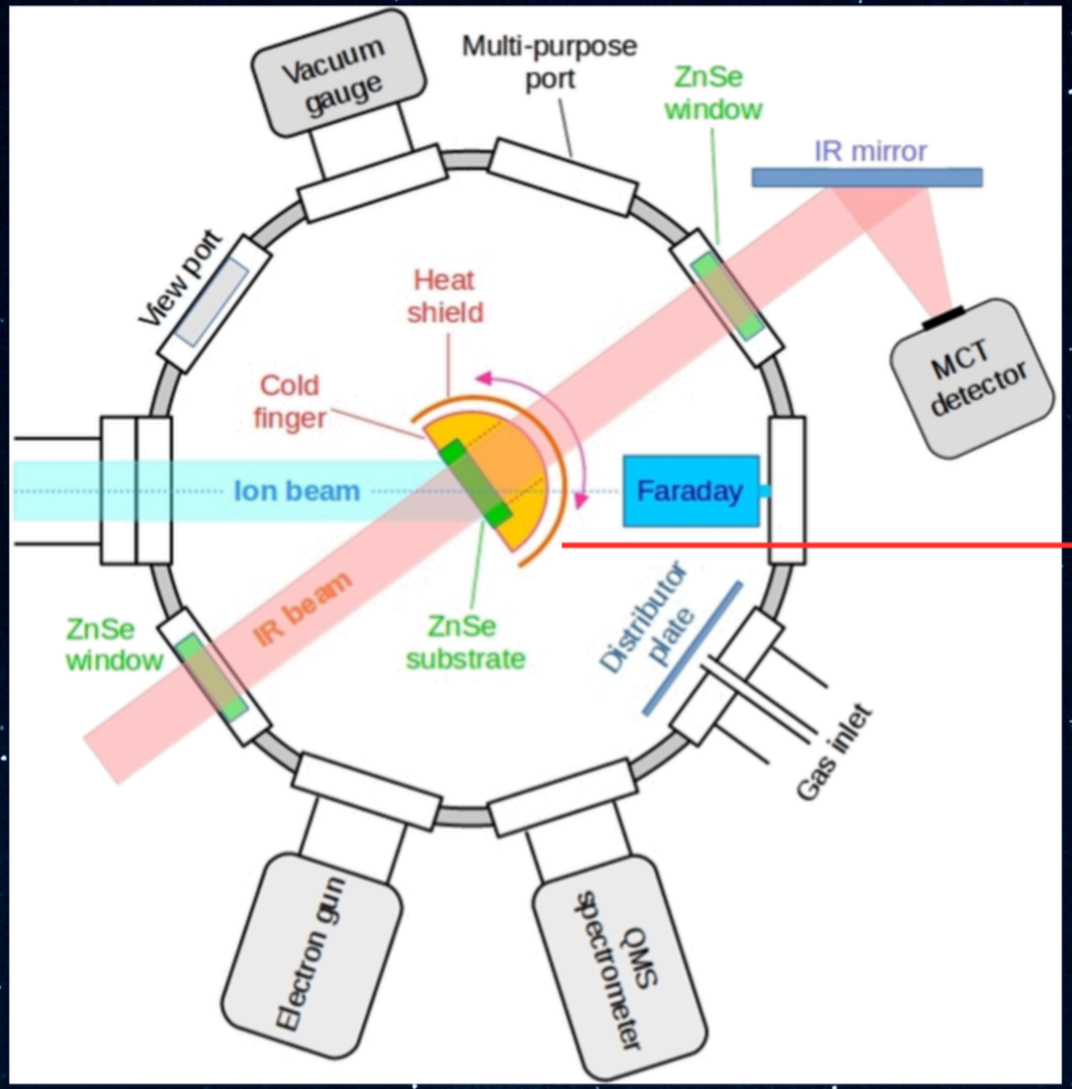
METHODOLOGY





Tandetron Laboratory. Credit: HUN-REN ATOMKI.

METHODOLOGY





Schematic diagram of the ICA chamber arranged for transmission FTIR absorbance spectroscopy. Credit: Herczku *et al*; 2001.

Amorphous

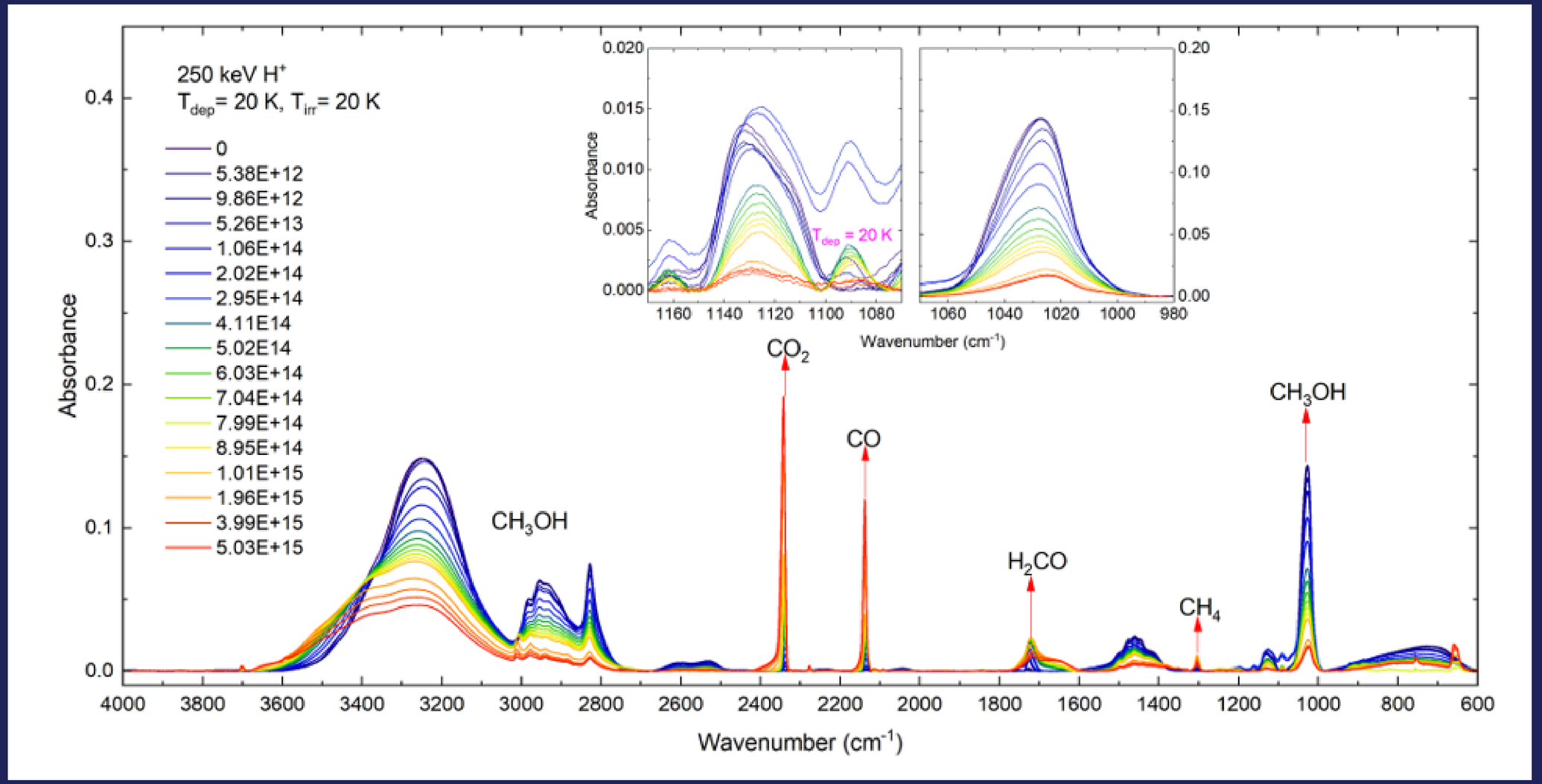


Figure 1. Identification of Products Formed after Irradiation of Amorphous Methanol Ice at 250 keV.

Crystalline

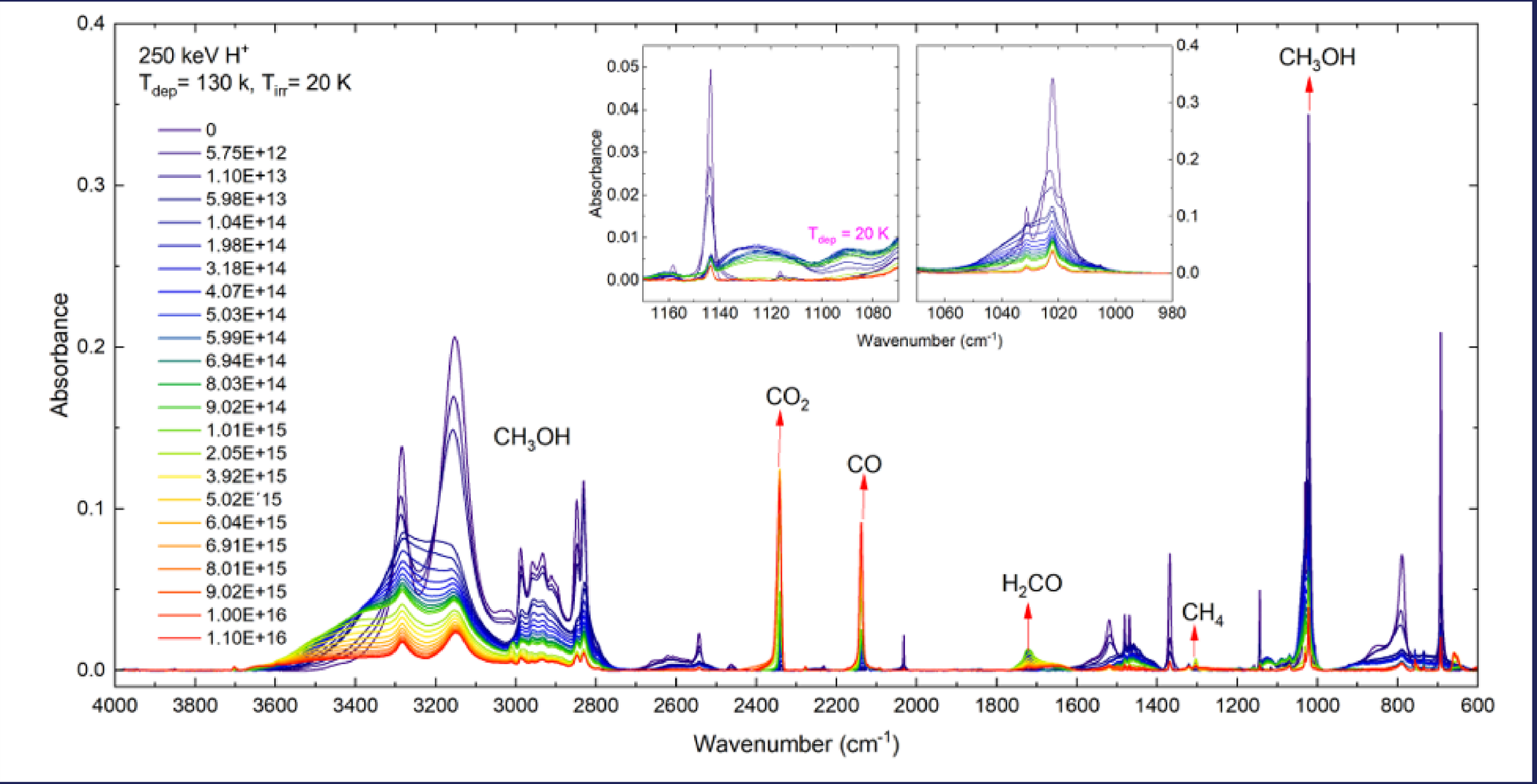


Figure 2. Identification of Products Formed after Irradiation of Crystalline Methanol Ice at 250 keV.

Amorphous

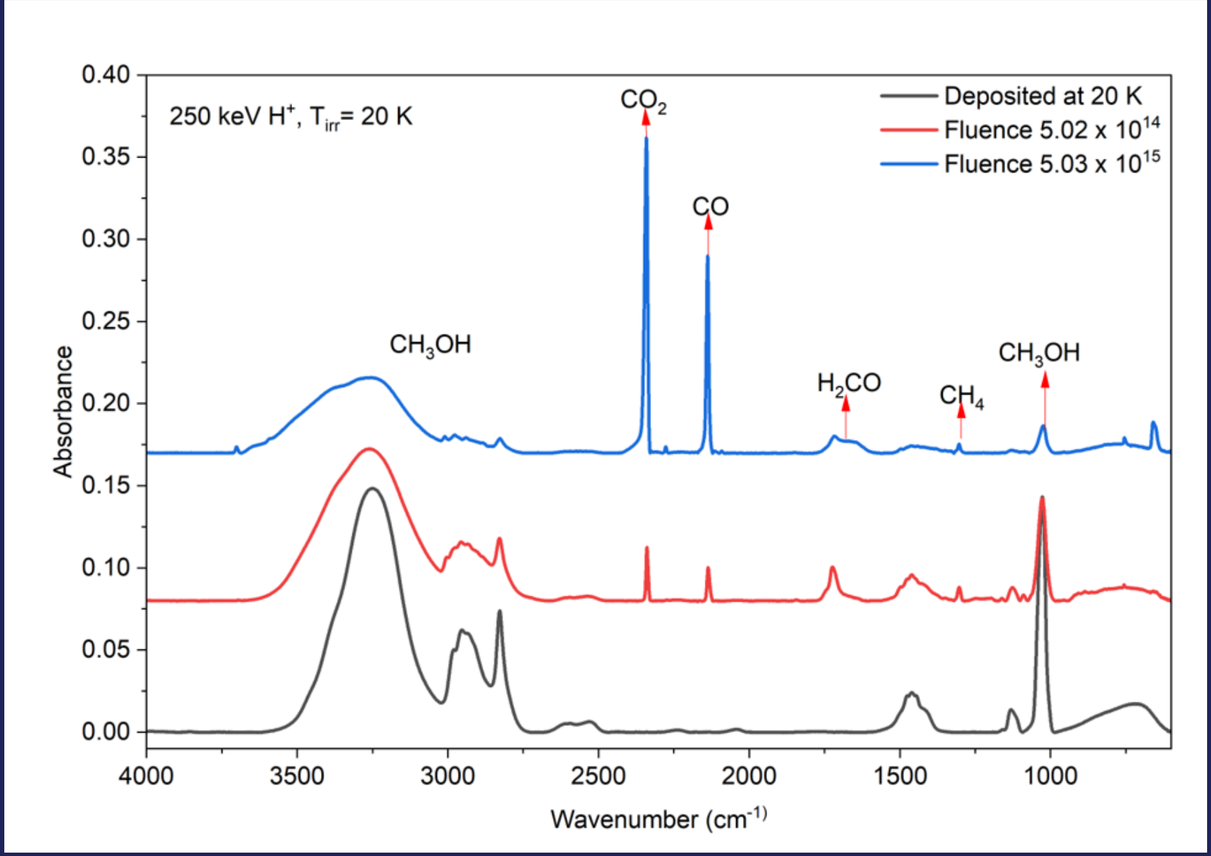


Figure 3. FTIR absorbance spectra of amorphous CH_3OH ice evolution under 250 keV H^+ radiolysis.

Crystalline

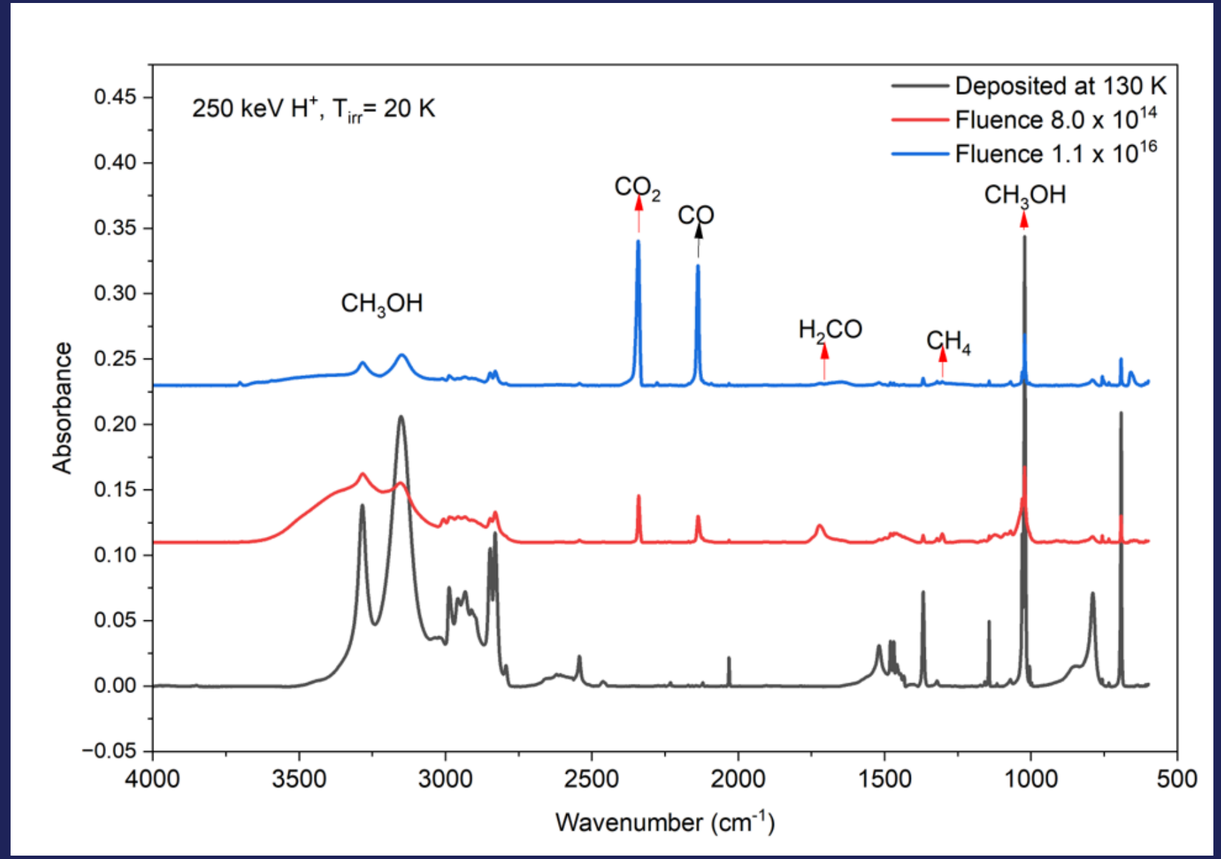


Figure 4. FTIR absorbance spectra of crystalline CH_3OH ice evolution under 250 keV H^+ radiolysis.

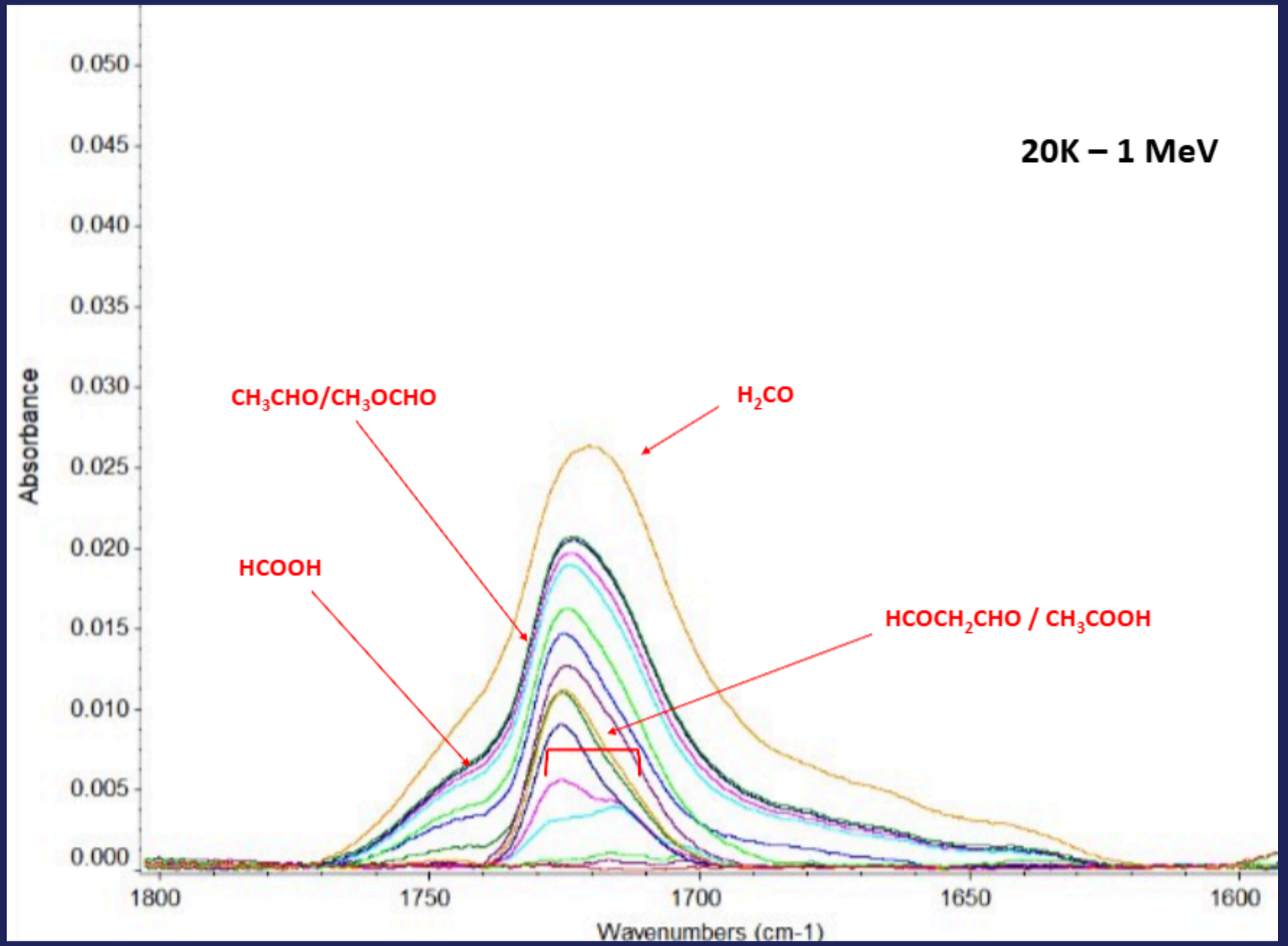


Figure 5. Formaldehyde Region

Amorphous

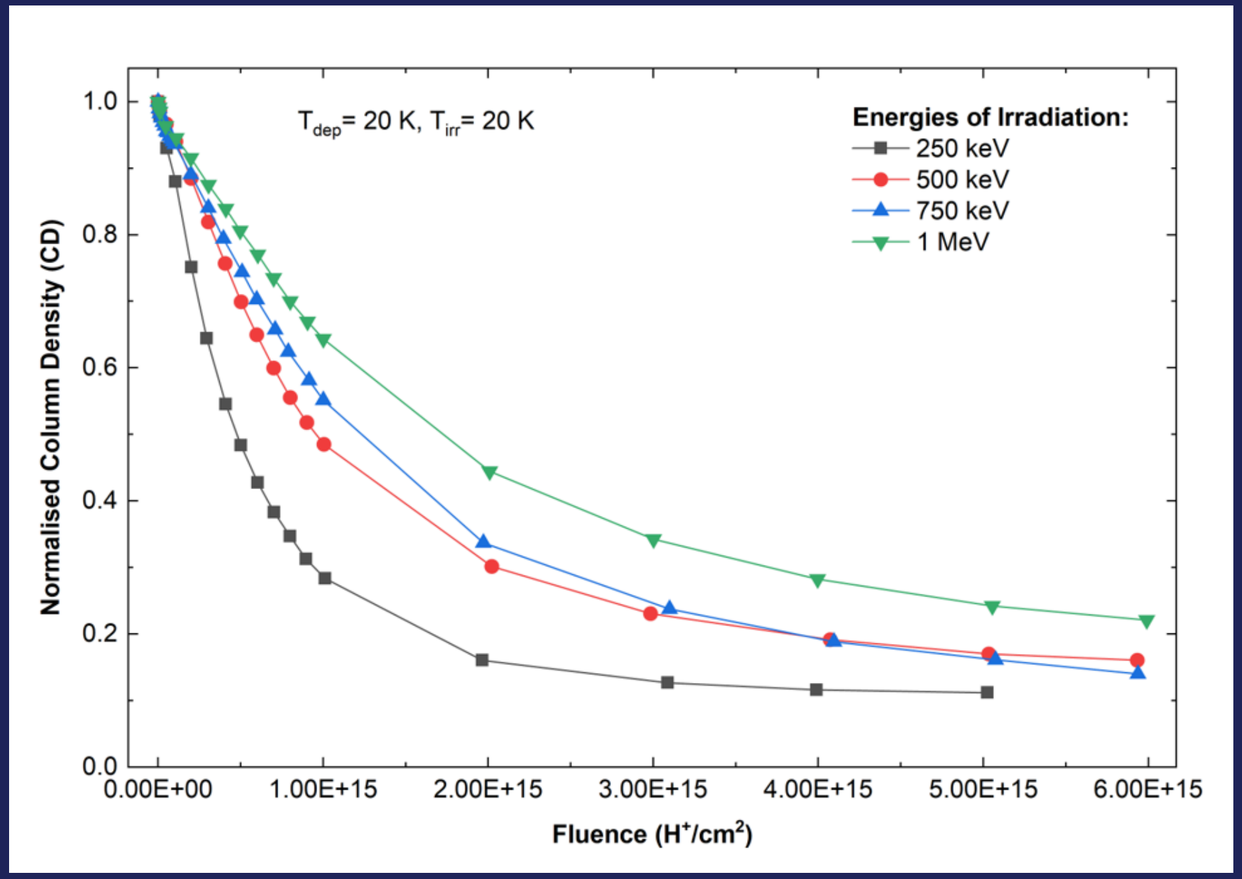


Figure 6. Evolution of amorphous CH_3OH ice column density (absorbance peak at ~1020 cm^{-1}) with increasing dose of proton.

Crystalline

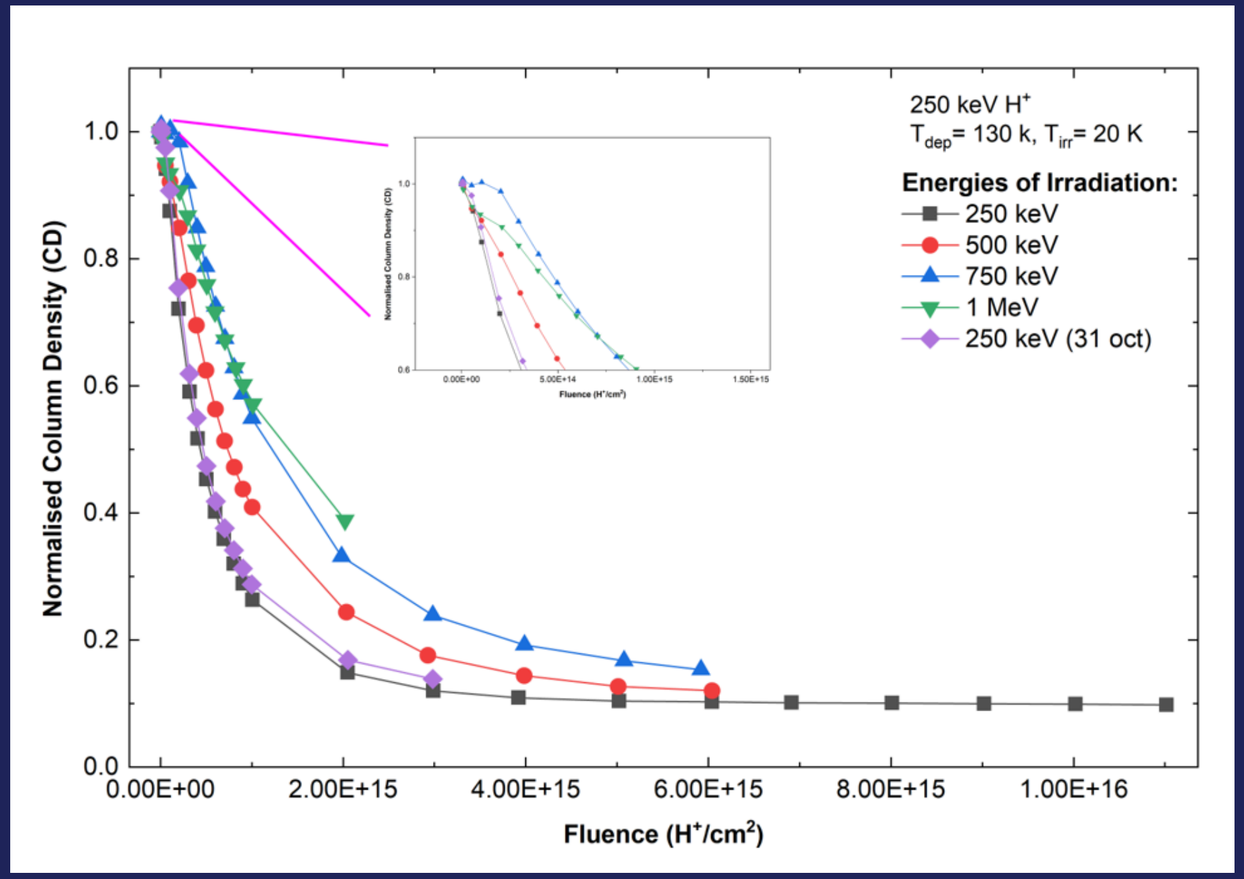


Figure 7. Evolution of crystalline CH_3OH ice column density (absorbance peak at ~1020 cm^{-1}) with increasing dose of proton.

Amorphous

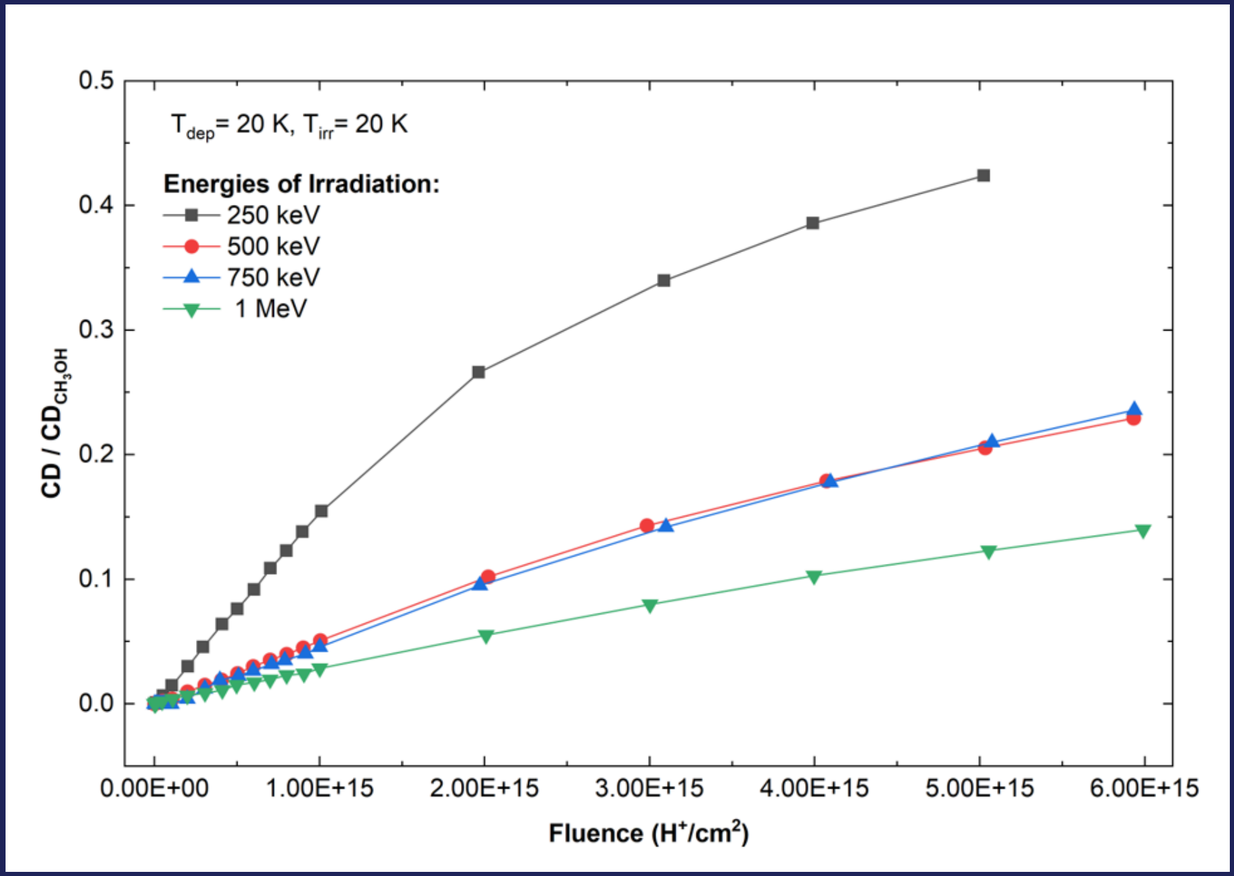


Figure 8. Evolution of CO column density (amorphous phase).

Crystalline

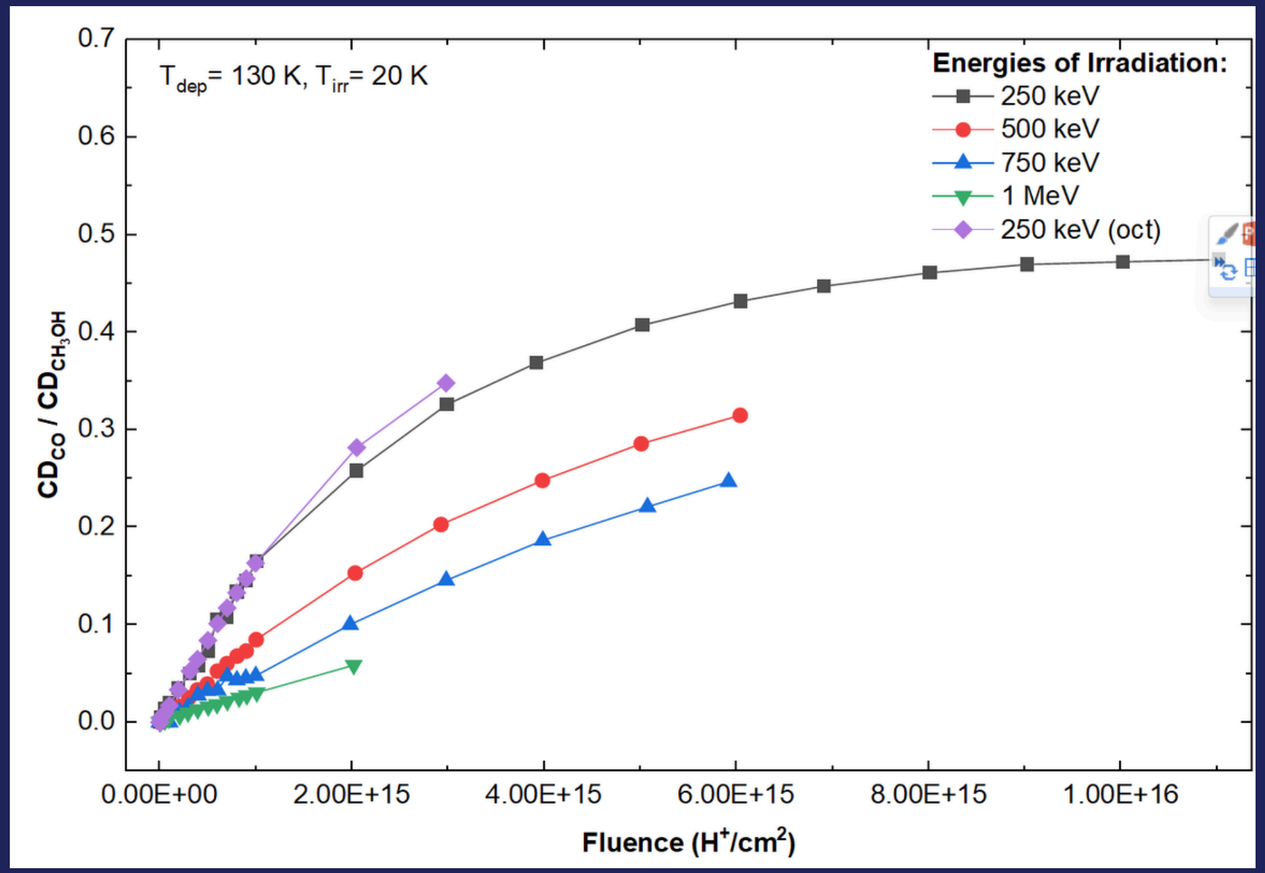


Figure 9. Evolution of CO column density (crystalline phase).

Amorphous

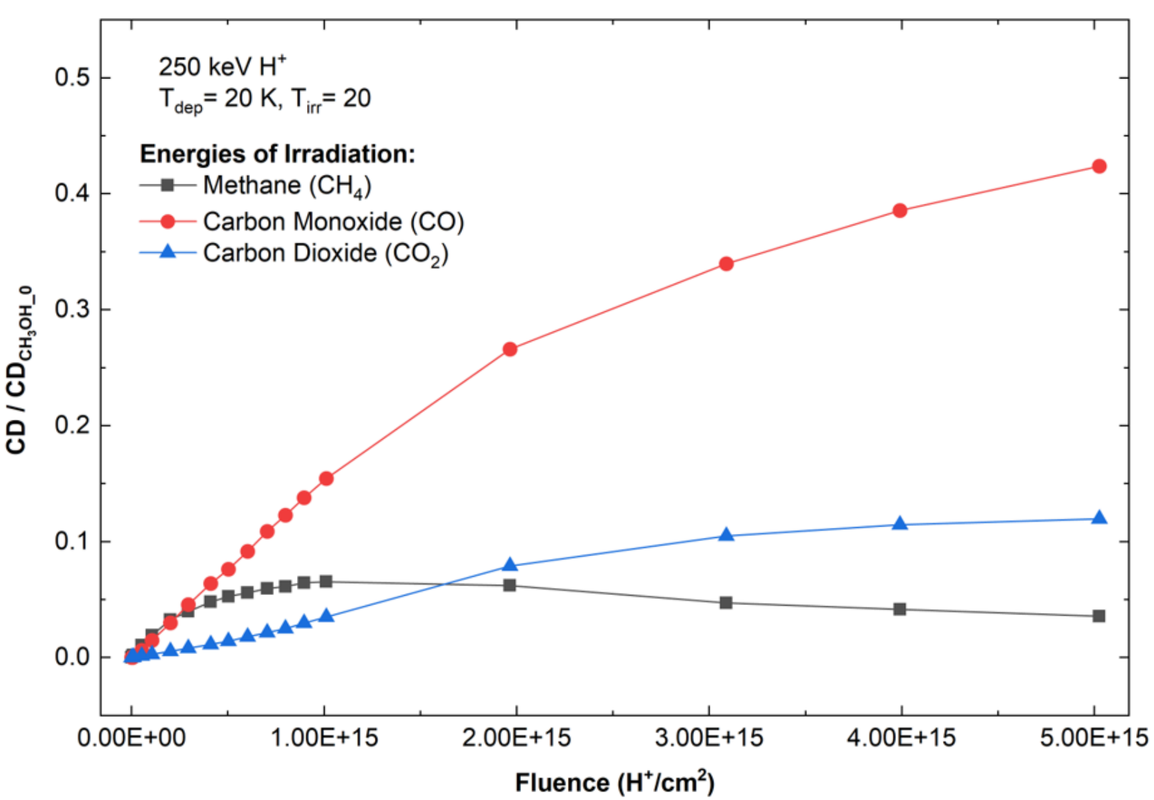


Figure 10. Formation of new compounds induced by 250 keV irradiation.

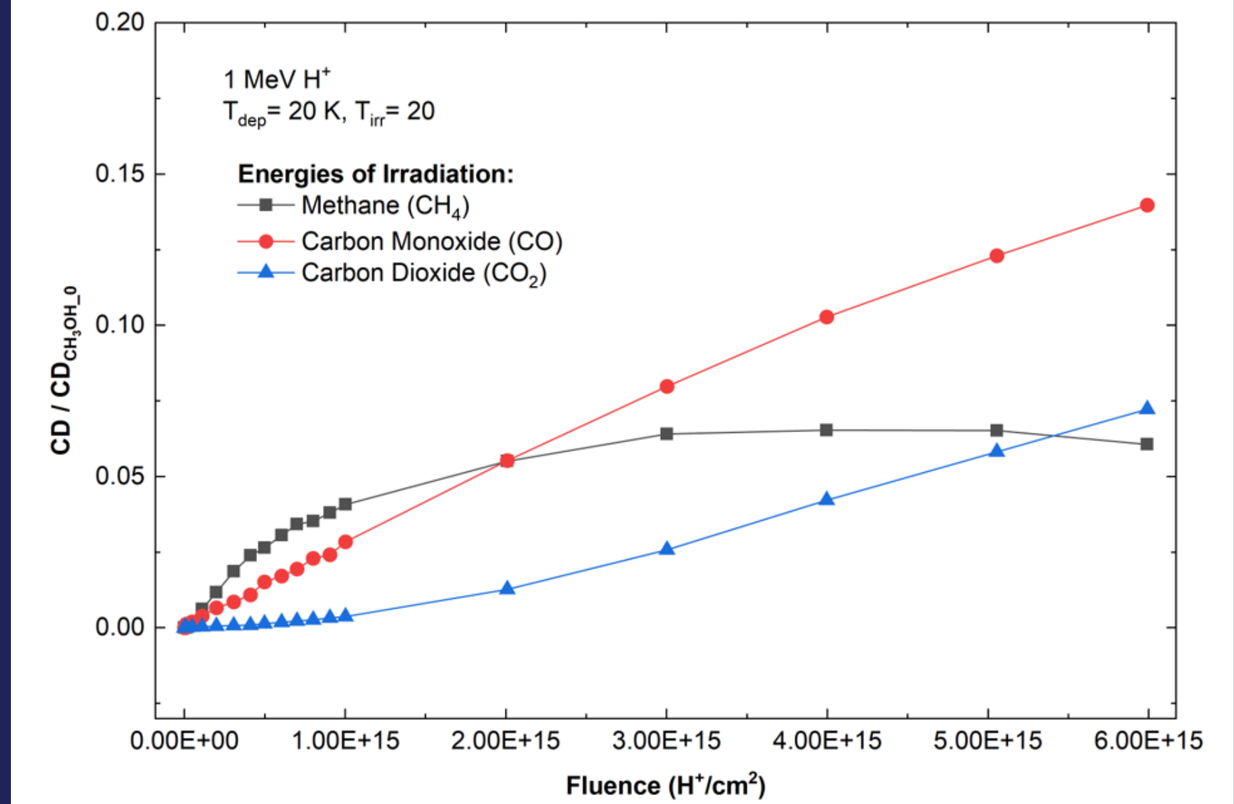


Figure 11. Formation of new compounds induced by 1 MeV irradiation.

Crystalline

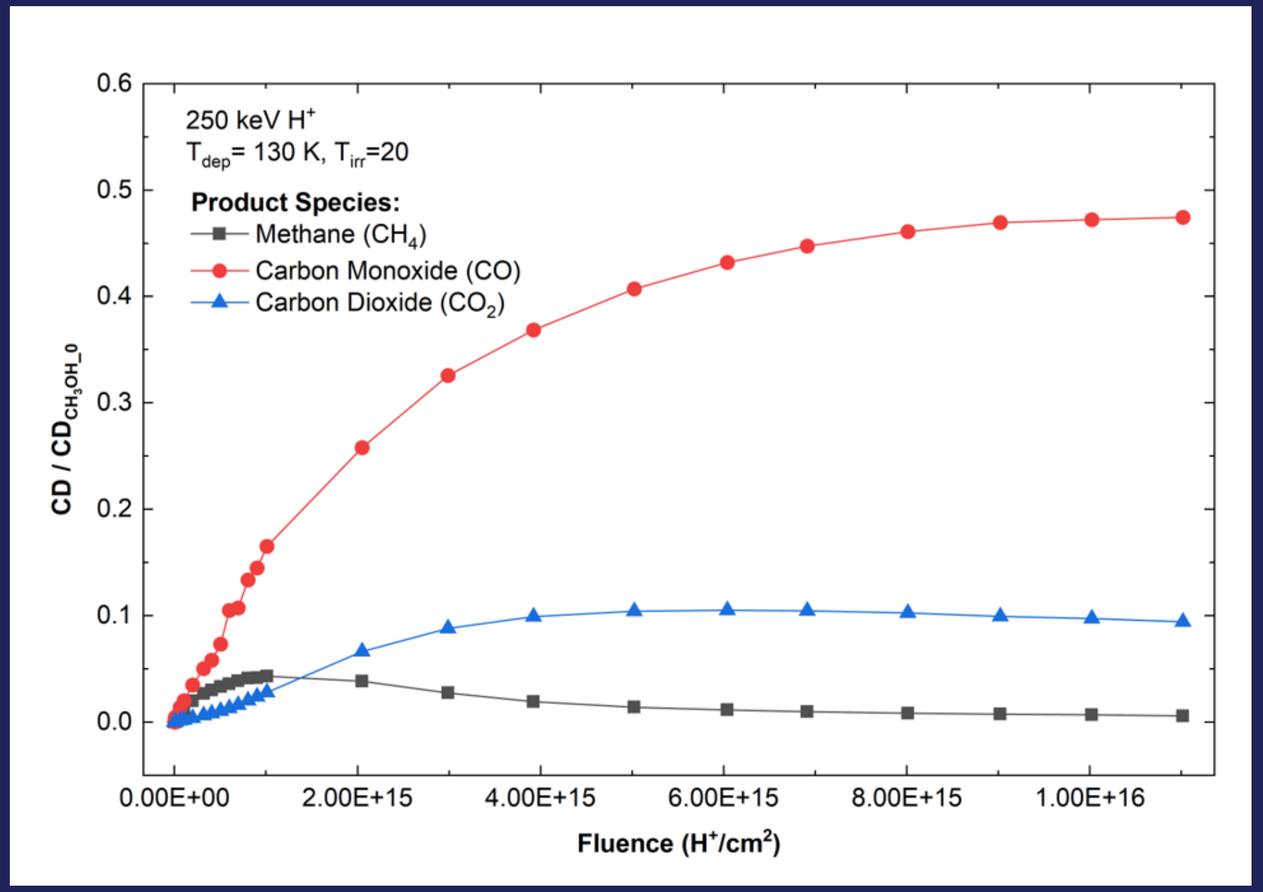


Figure 12. Formation of new compounds induced by 250 keV irradiation.

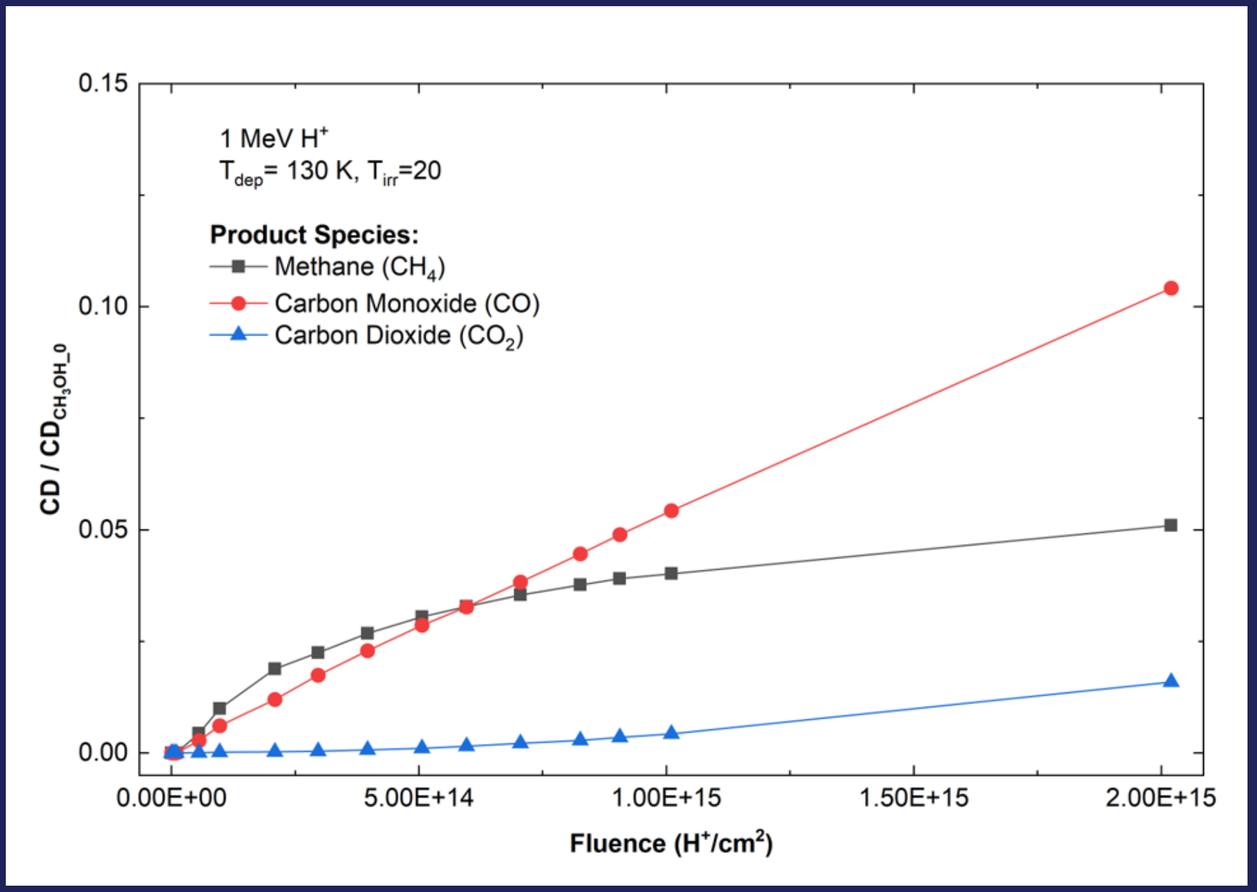


Figure 13. Formation of new compounds induced by 1 MeV irradiation.

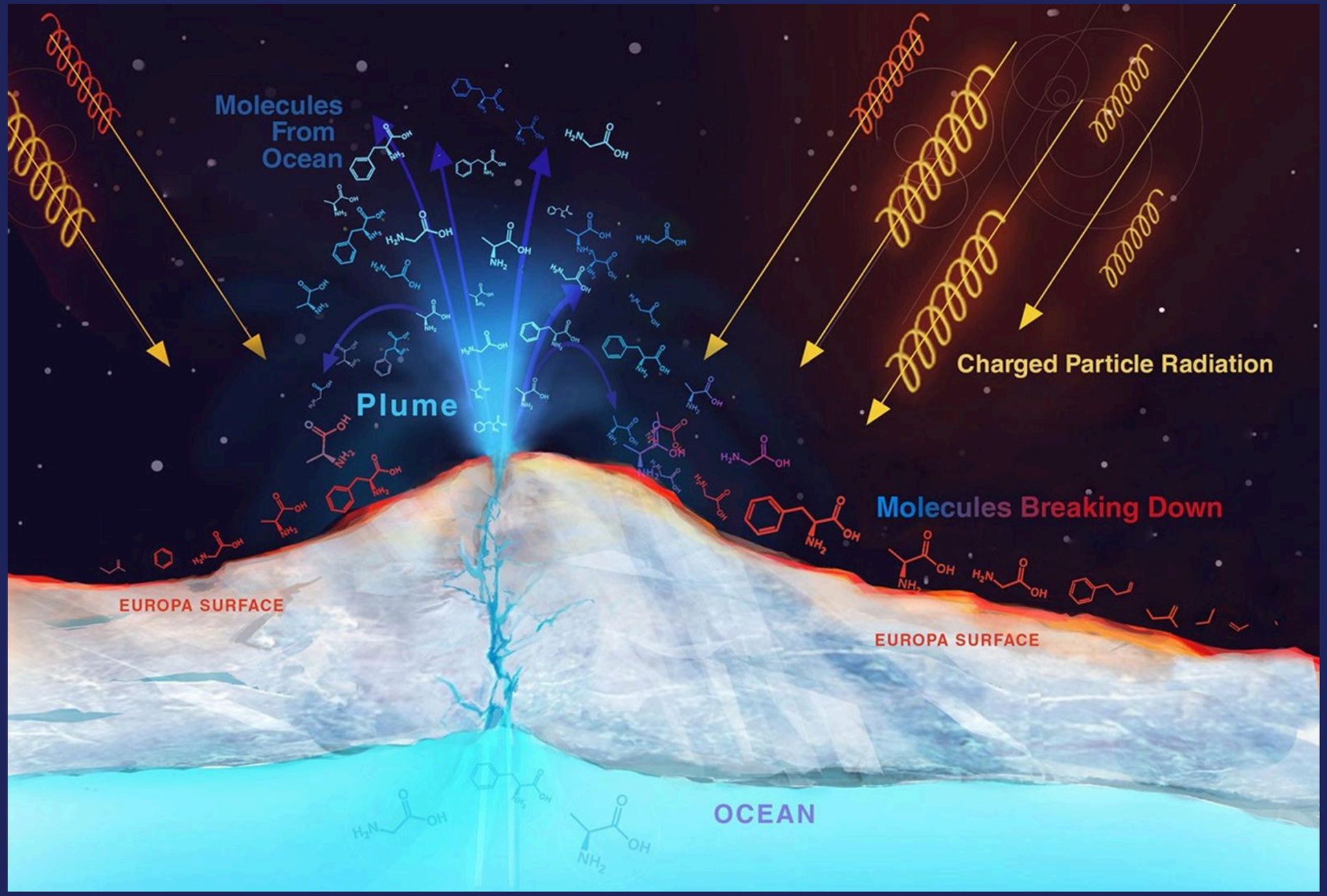
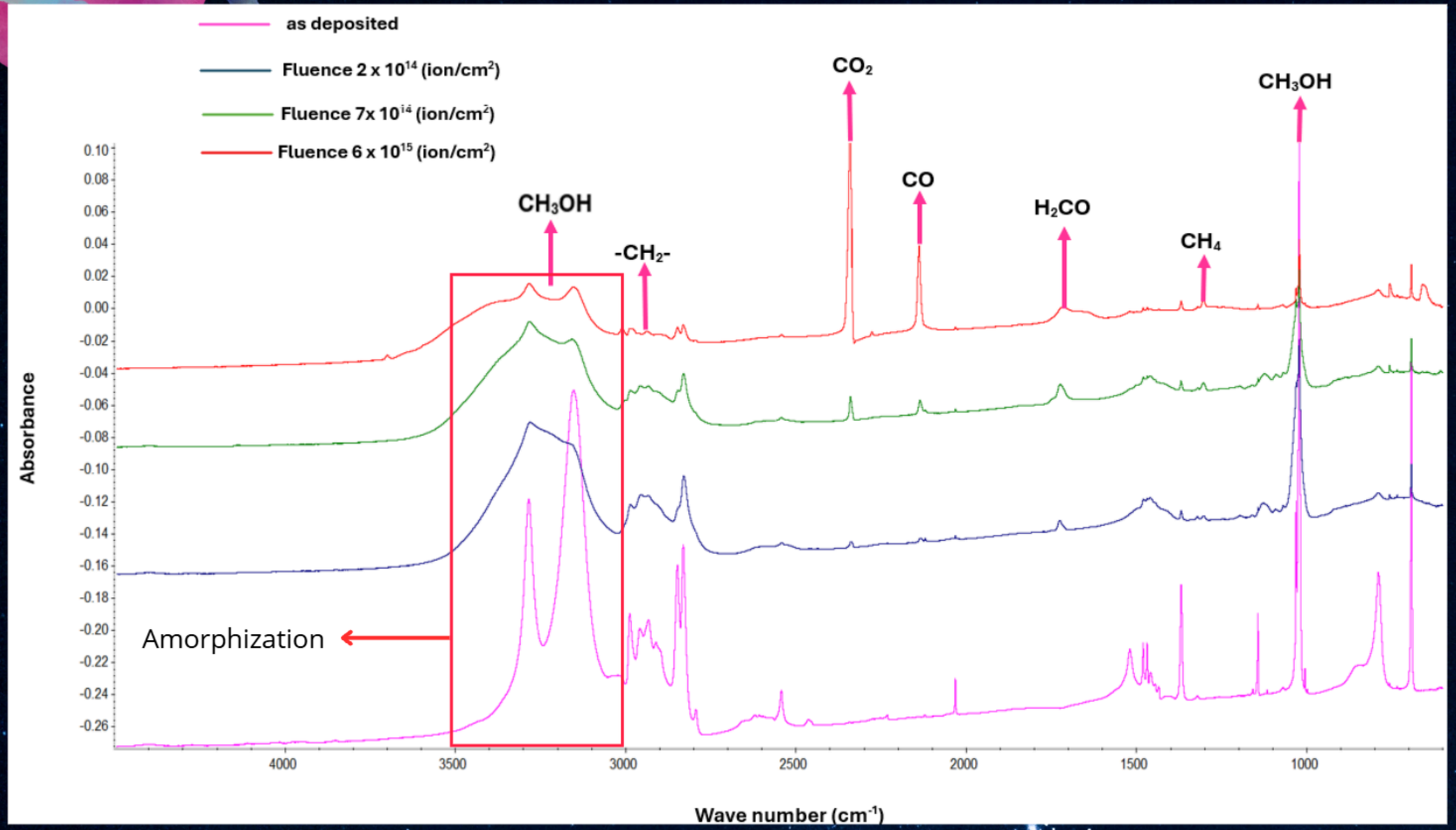


Figure 19. Irradiation of the surfaces of icy moons, promoting chemical evolution. Credit: NASA/JPL-Caltech.

AMORPHIZATION



Temperature: 130 K

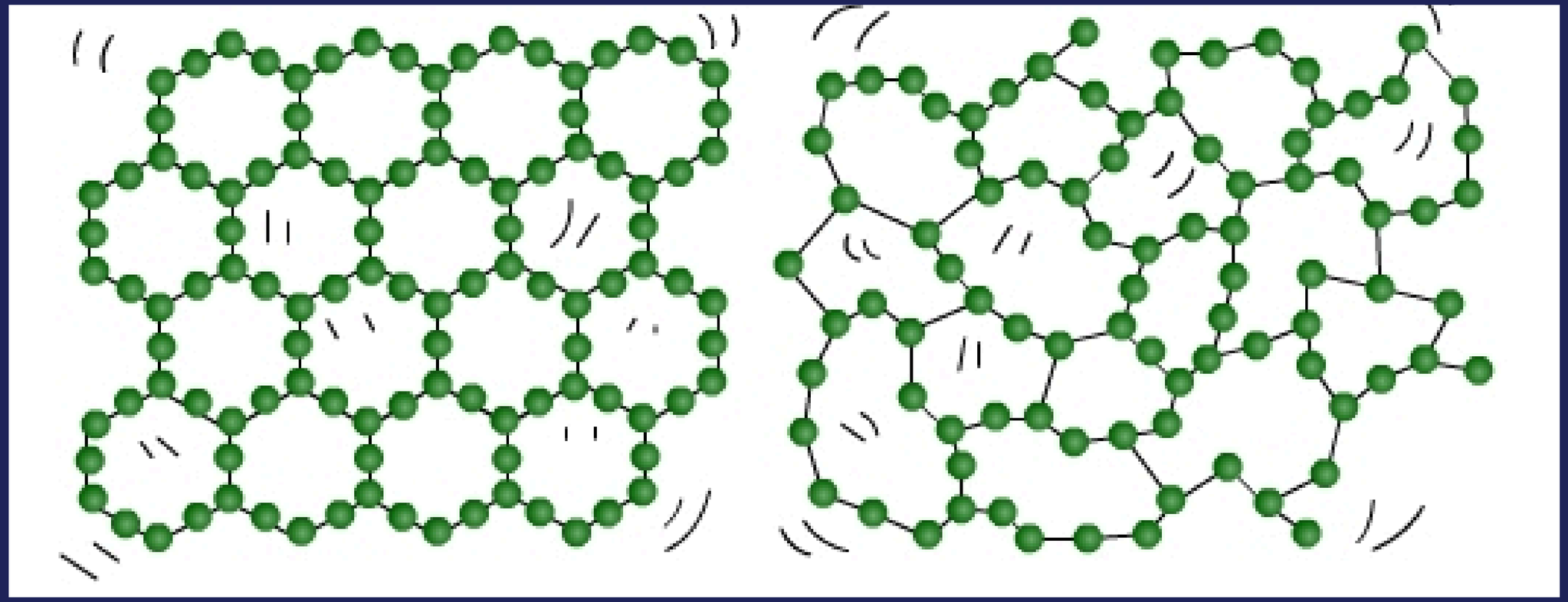
Pressure: 10^{-9} mbar

Amorphization process of crystalline ice.









Crystaline



Amorphous

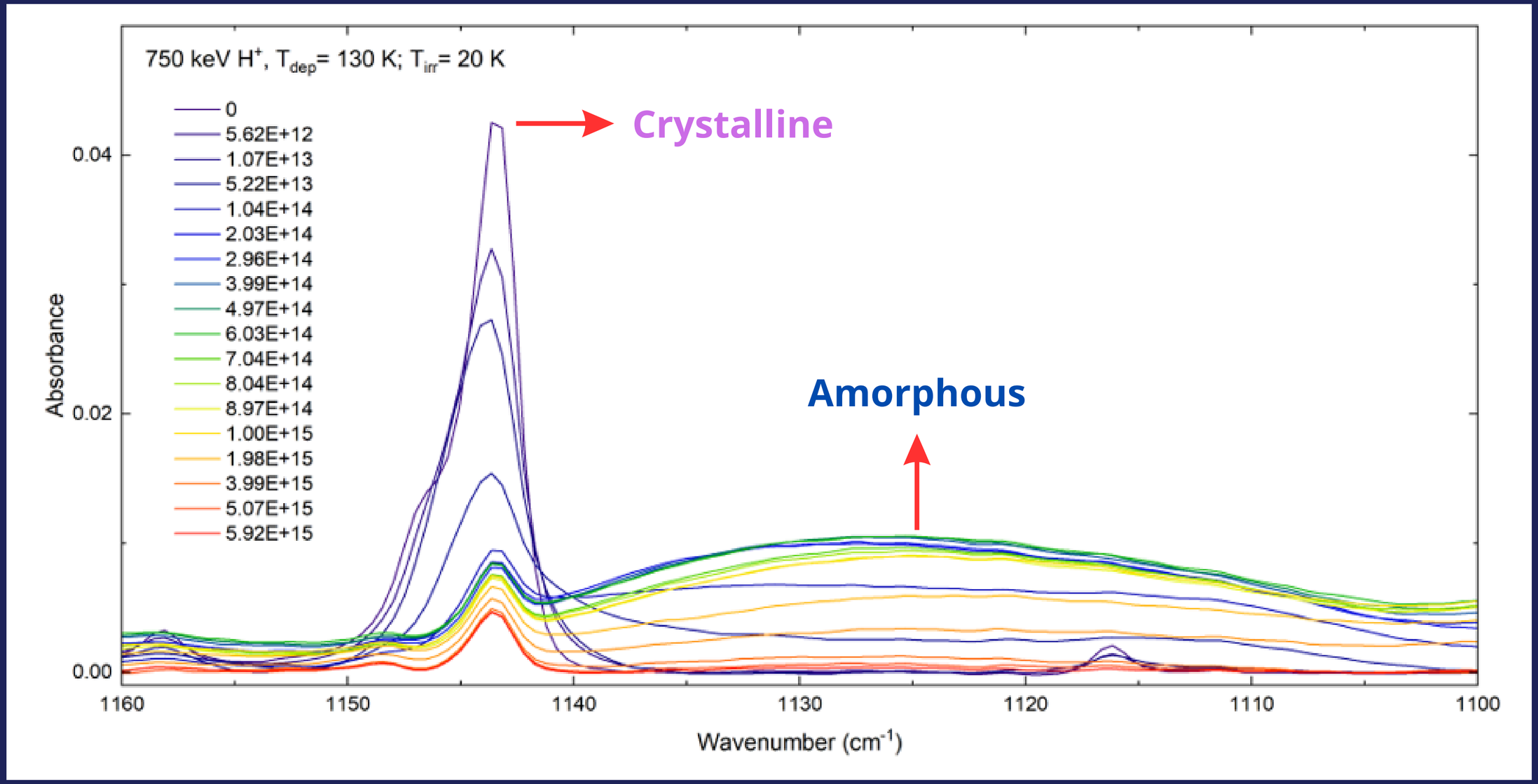


Figure 10. Infrared spectra showing the amorphization CH_3OH ice.

Amorphization

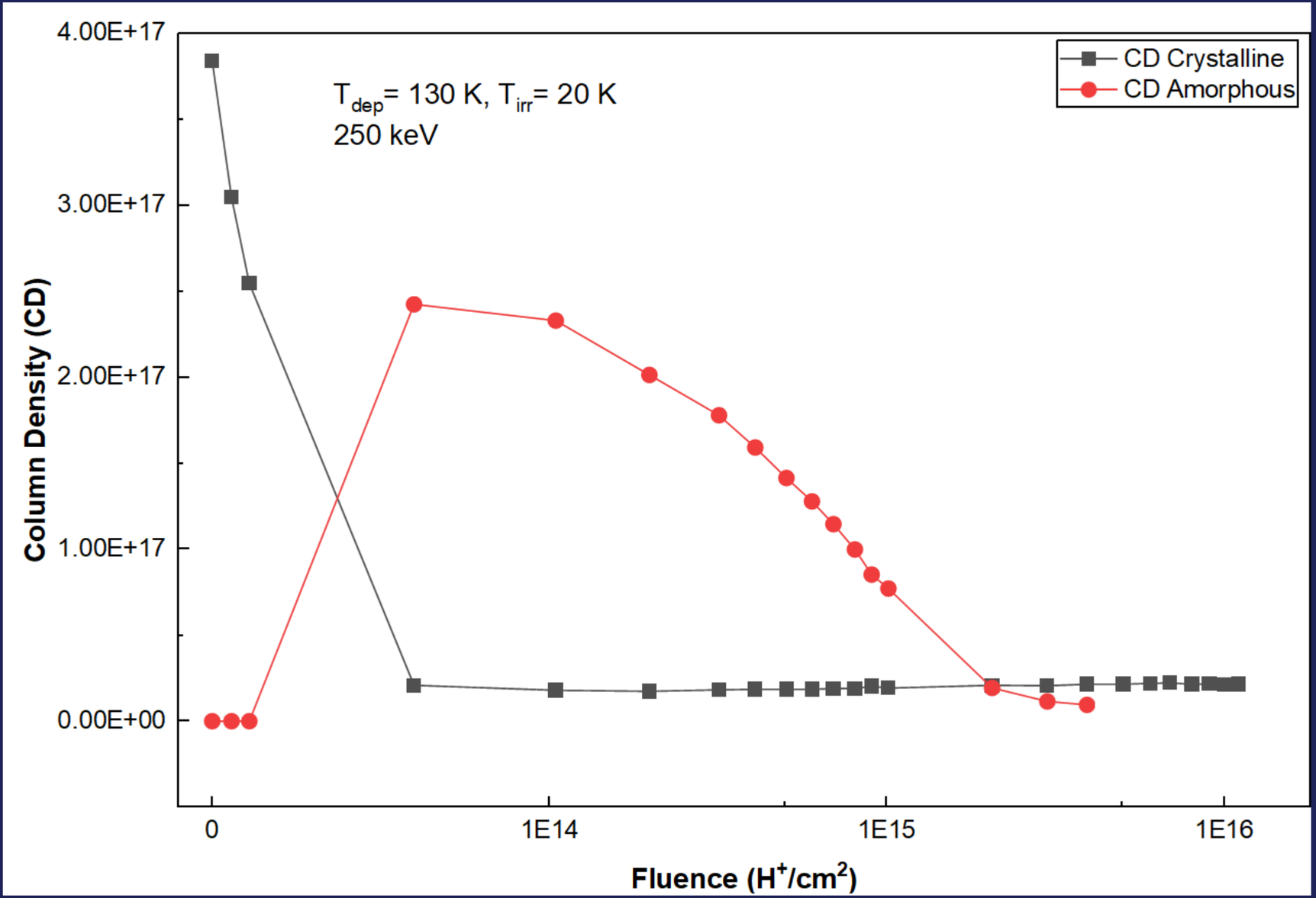


Figure 11. Evolution of the amorphization process.

PRELIMINARY CONCLUSIONS.





•Radiation promotes the formation of new chemical compounds of astrobiological relevance.

•Radiation induces a structural transformation of crystalline ice into its amorphous form, which is still under investigation.

•These morphological and chemical changes would help to understand the evolution of icy moon surfaces.







ACKNOWLEDGMENTS



Professor. Nigel J. Mason



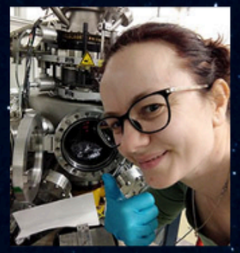
Dr. Herczku Péter



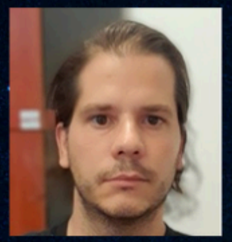
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