The role of cosmic rays and other energetic phenomena in the chemistry of P-bearing molecules in the Galactic Center

Víctor M. Rivilla[1], Izaskun Jiménez-Serra[2], Shaoshang Zeng[2], Sergio Martín[3,4], Jesús Martín-Pintado[5], Jairo Armijos-Abendaño, Serena Viti[7], Rebeca Aladro[8], Denisse Riquelme[8], Miguel A. Requena-Torres[9], David Quénard[2], Francesco Fontani[1], Maite Beltrán[1]

[1] INAF-Osservatorio Astrofisico di Arcetri, Italy; [2]Queen Mary University of London, UK; [3]ALMA Observatory,Chile; [4]ESO, Chile; [5]Centro de Astrobiología, INTA-CSIC, Spain; [6]Observatorio Astronómico de Quito, Ecuador; [7]UCL, UK; [8]MPIR, Germany; [9]University of Maryland,USA

- **Phosphorus (P)** is essential for the development of Life due to its central role in biochemical processes.
- The chemistry of P remains poorly understood.
- We present observations of P-bearing molecules across the Central Molecular Zone (CMZ) in the Galactic Center, whose chemistry is affected by energetic phenomena: cosmic rays, X-rays, UV radiation, and shocks.

T_{dust} < 30 K, too cold for the evaporation of ices.

The Central Molecular Zone (CMZ) of the Galaxy

Dust grain sputtering by widespread low-velocity shocks.

G+0.693-0.03
SgrB2 N
SgrB2 M

S+0.24+0.01

M+0.02-0.02
SgrA*(-30”,-30”)
M-0.02-0.07

THE SAMPLE: IRAM 30m observations of PN(2-1) towards 7 regions of the Galactic Center

Shock-dominated regions

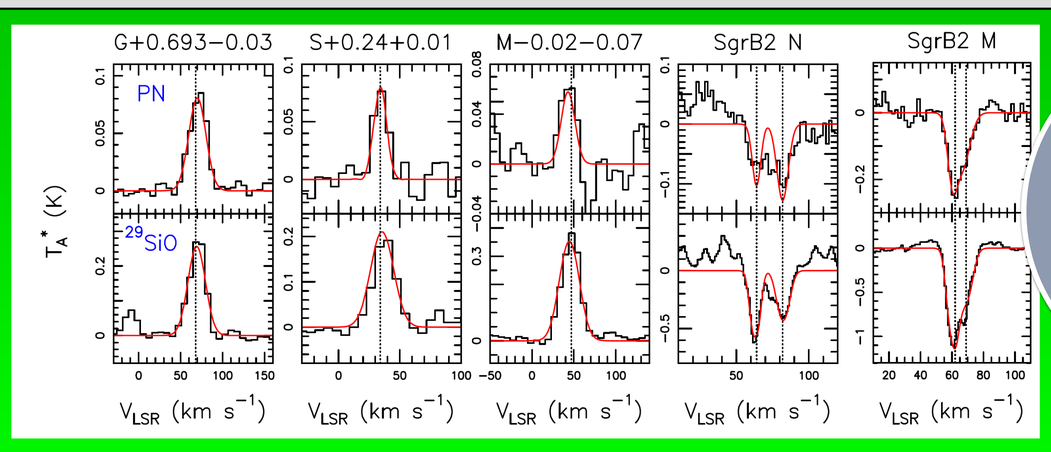
Colder envelopes of protostellar hot molecular cores

COMs-rich quiescent clouds

Radiation-dominated regions

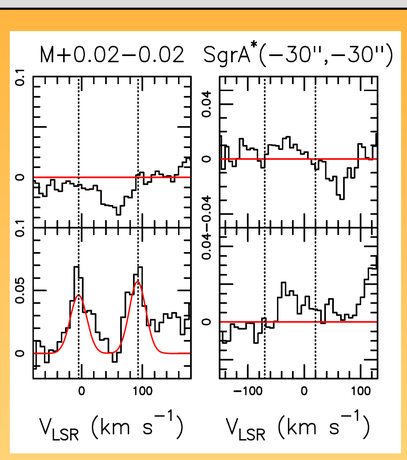
Cosmic-rays
X-rays
UV radiation

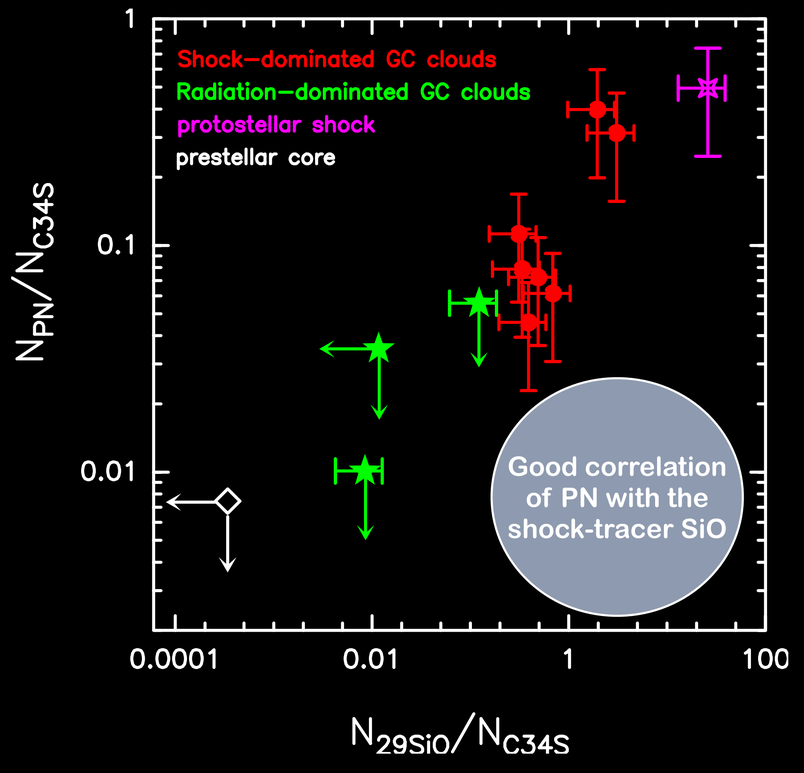
✓ PN detections



Rivilla et al. 2018

✗ PN non detections





Conclusions

- P-bearing molecules likely form in shocked gas as a result of dust grain sputtering.
- P-bearing molecules are destroyed by intense Cosmic-ray / UV / X-ray radiation.
- Observational results confirmed by new chemical models of P-bearing molecules under energetic phenomena (Jiménez-Serra et al., submitted).