Laboratory formation of fullerenes from PAHs: Top-down interstellar chemistry.

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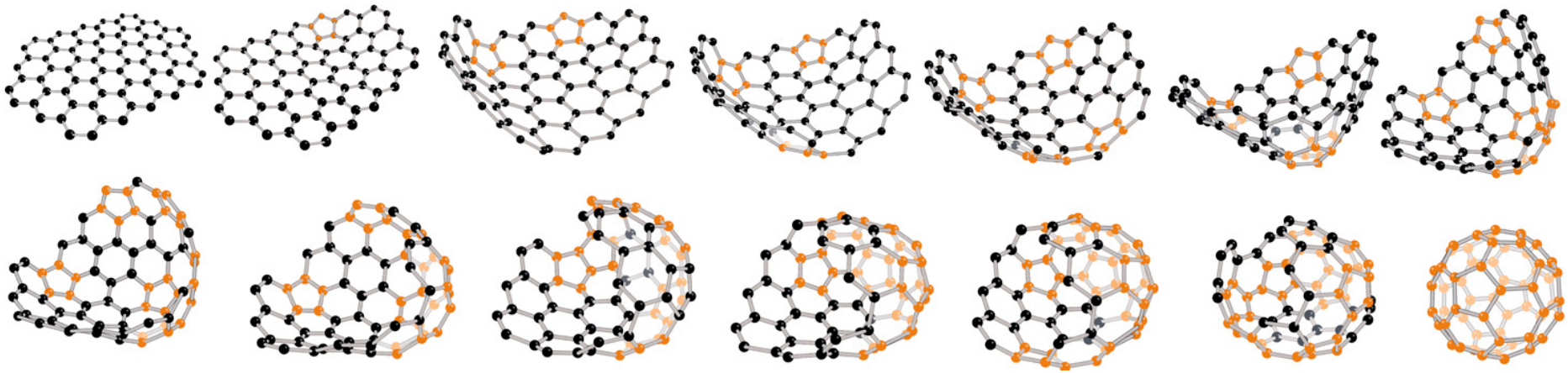
Outline

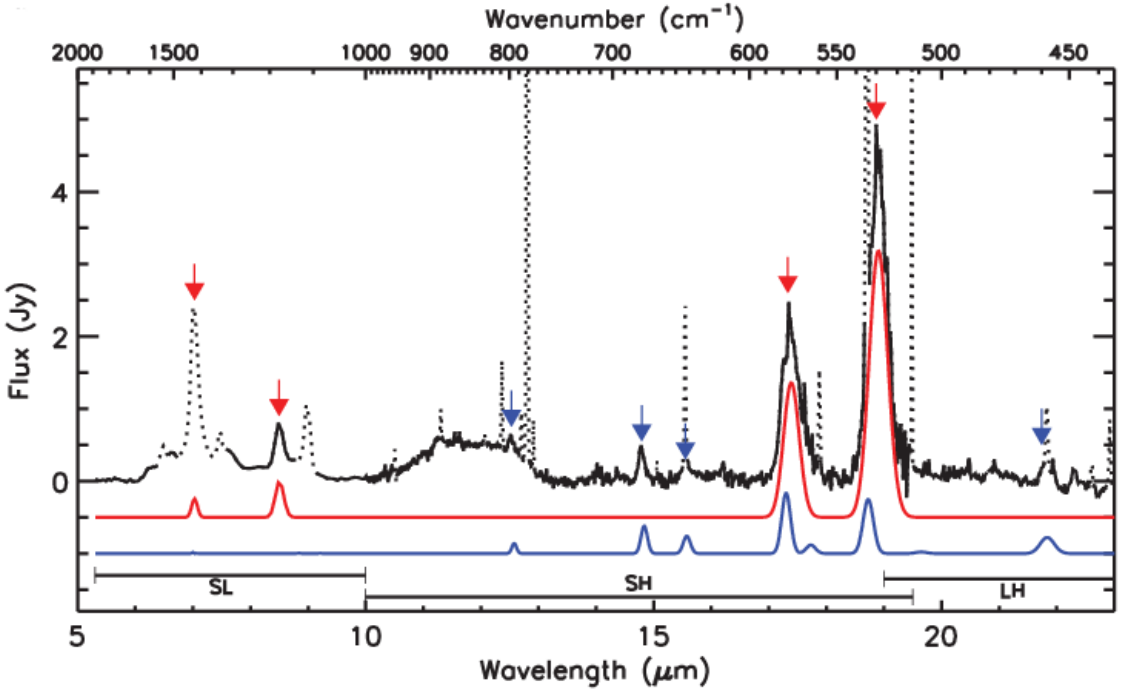
Why C_{60}?

- C_{60} (and C_{70}) are the largest molecules detected in the ISM.
- Highly stable molecule.
- Its formation is related to other carbon bearing compounds.
- Ubiquitous in the ISM.
- Possible culprit of some DIBs.



Observations

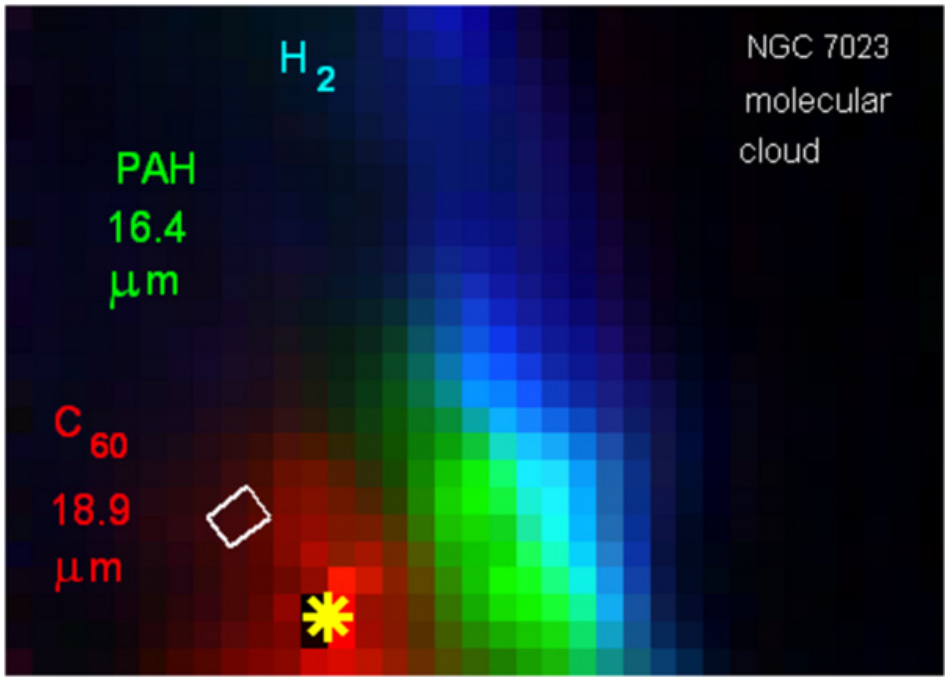
- First confirmed detection (along with C_{70}) in circumstellar environment of PN Tc 1 (Cami et al. 2010).
- Later detections in wide variety of environments and physical conditions: PNe, post-AGB stars, YSOs, Herbig Ae/Be and PDRs associated with RNe and HII regions.



Cami et al. (2010).

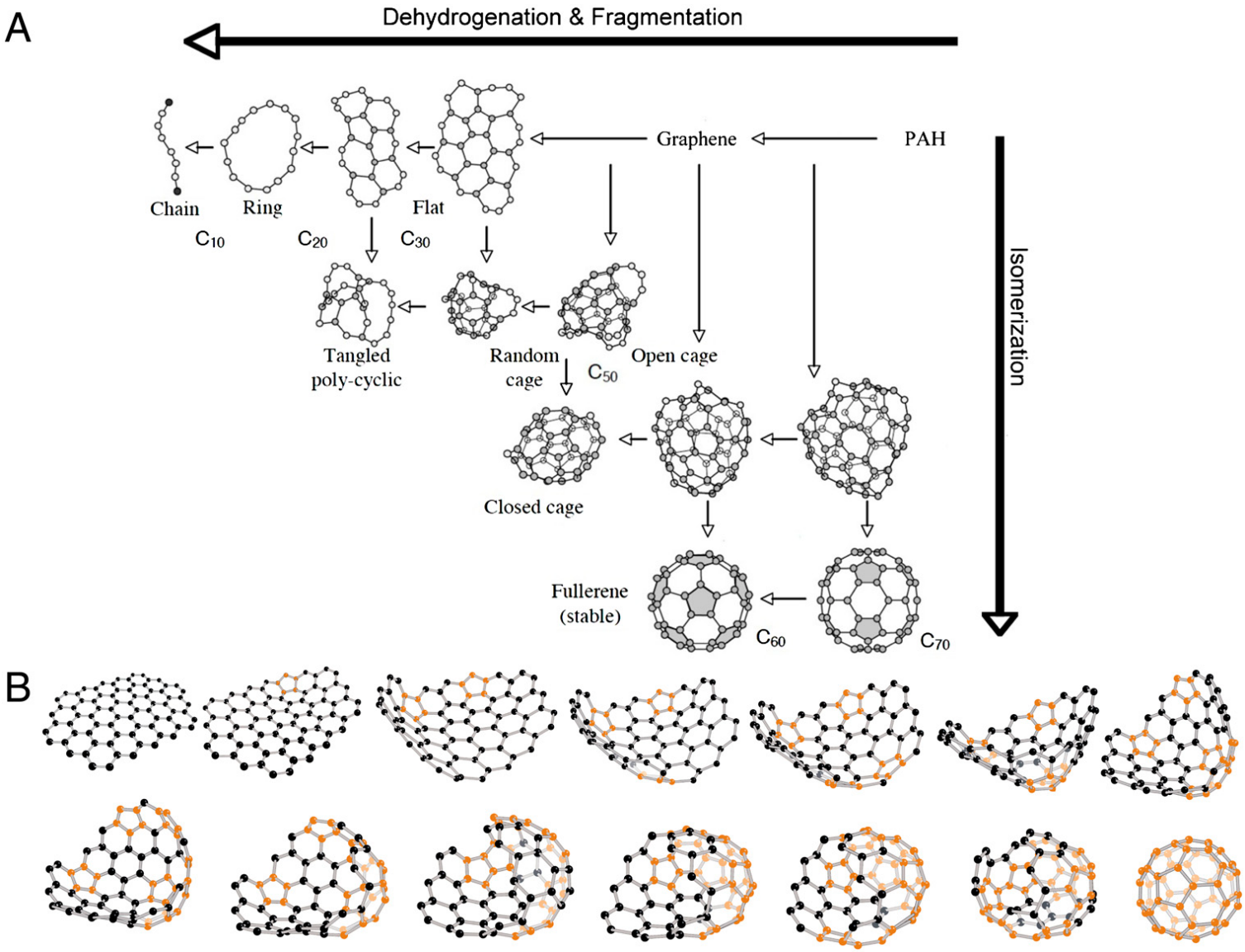
C_{60} Formation

- Formation in the envelope of AGBs has limited efficiency (Bernard-Salas et al. 2012).
- Berné & Tielens (2012) proposed that PAH dehydrogenation, followed by C_2-losses, can form C_{60}.
- Micelotta et al. (2012) propose a similar mechanism, but starting from HAC.



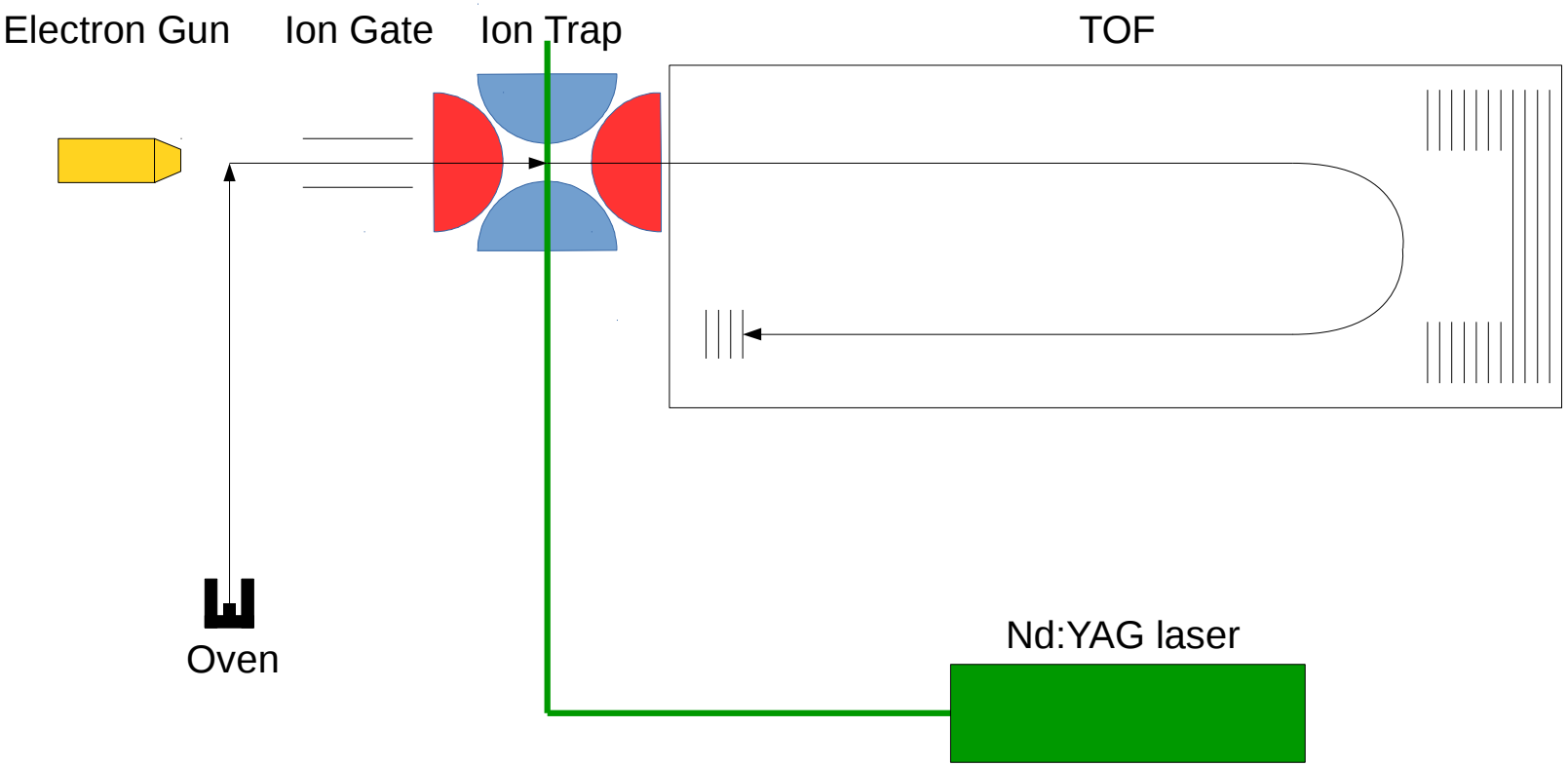
Sellgren et al. (2010).

Top-down Chemistry

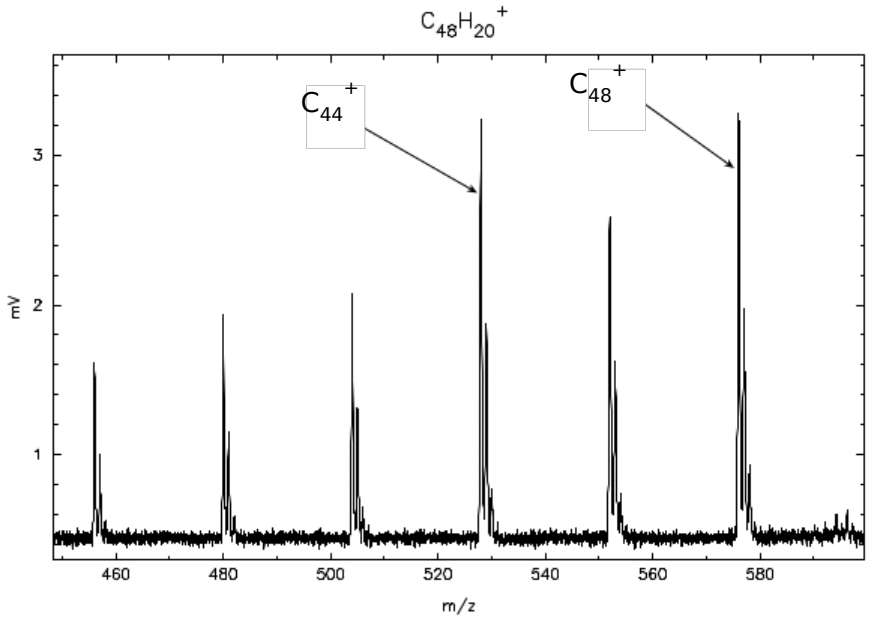


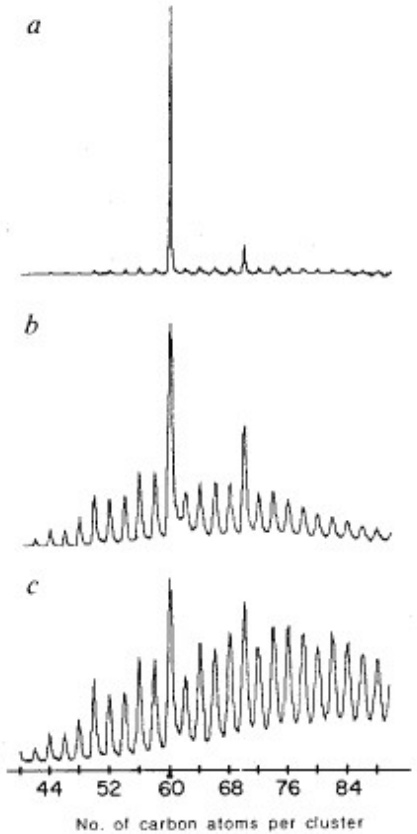
Berné & Tielens (2012).

i-PoP



“Magic Numbers”



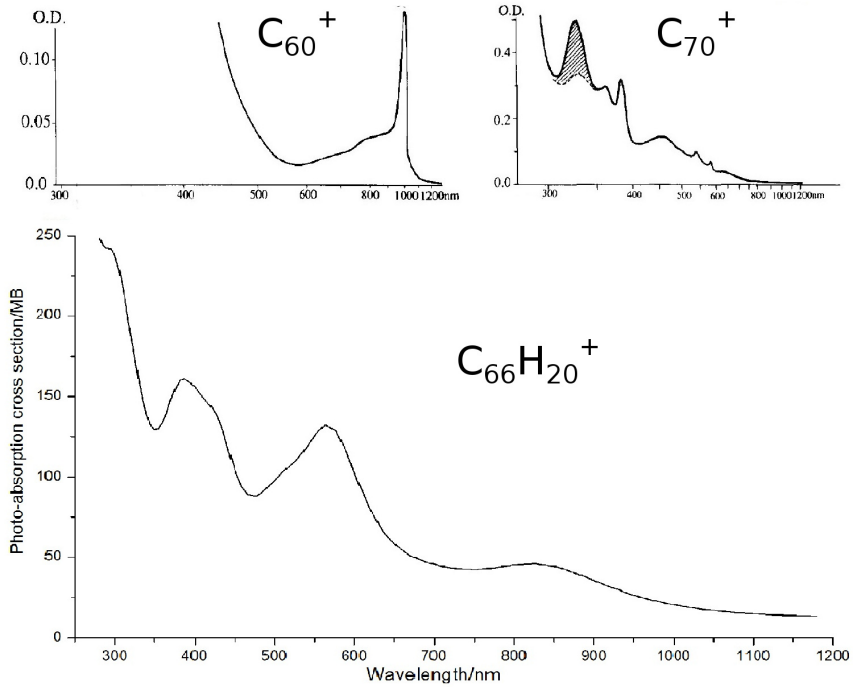


- Peaks enhanced in PAH dissociation.
- Formation of fullerenes shows peaks with enhanced intensity.
- “Magic numbers”: C_{44}, C_{50} and C_{56}.

Kroto et al. (1987)

Electronic Absorption Spectra

- C_{60} has an absorption minimum at ∼500–600 nm.
- C_{70} and large PAHs absorb efficiently.
- At shorter wavelengths the absorption becomes comparable for the three.



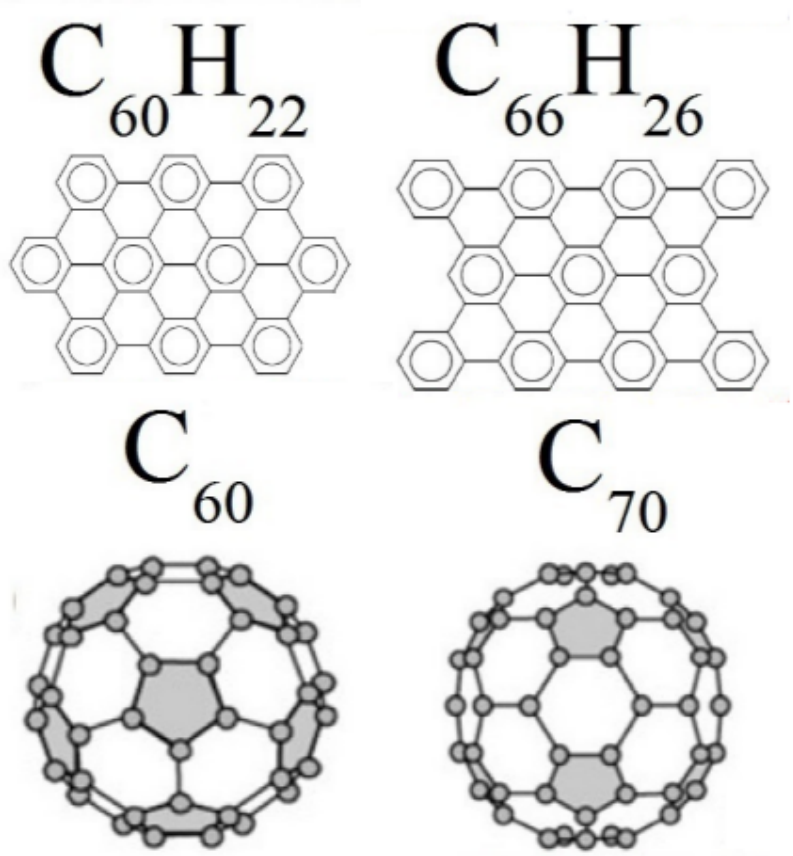
Tatsuhisa et al. (1991), Malloci et al. (2007)

Samples

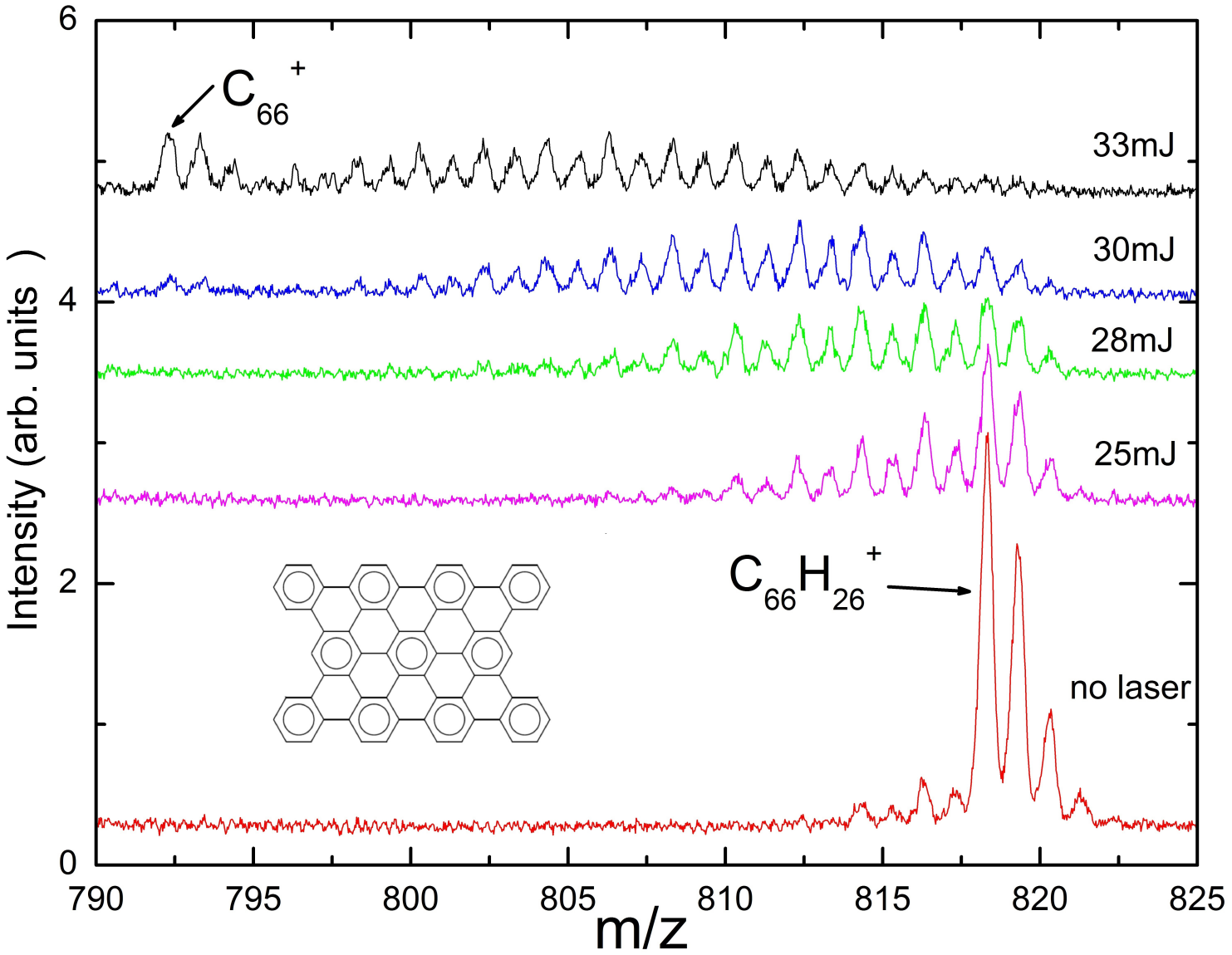
- Fullerenes follow "cage route" only.
- Irradiation with 266, 355 and 532 nm.
- C_{60}^{+} does not dissociate at 532 nm.

Goals:

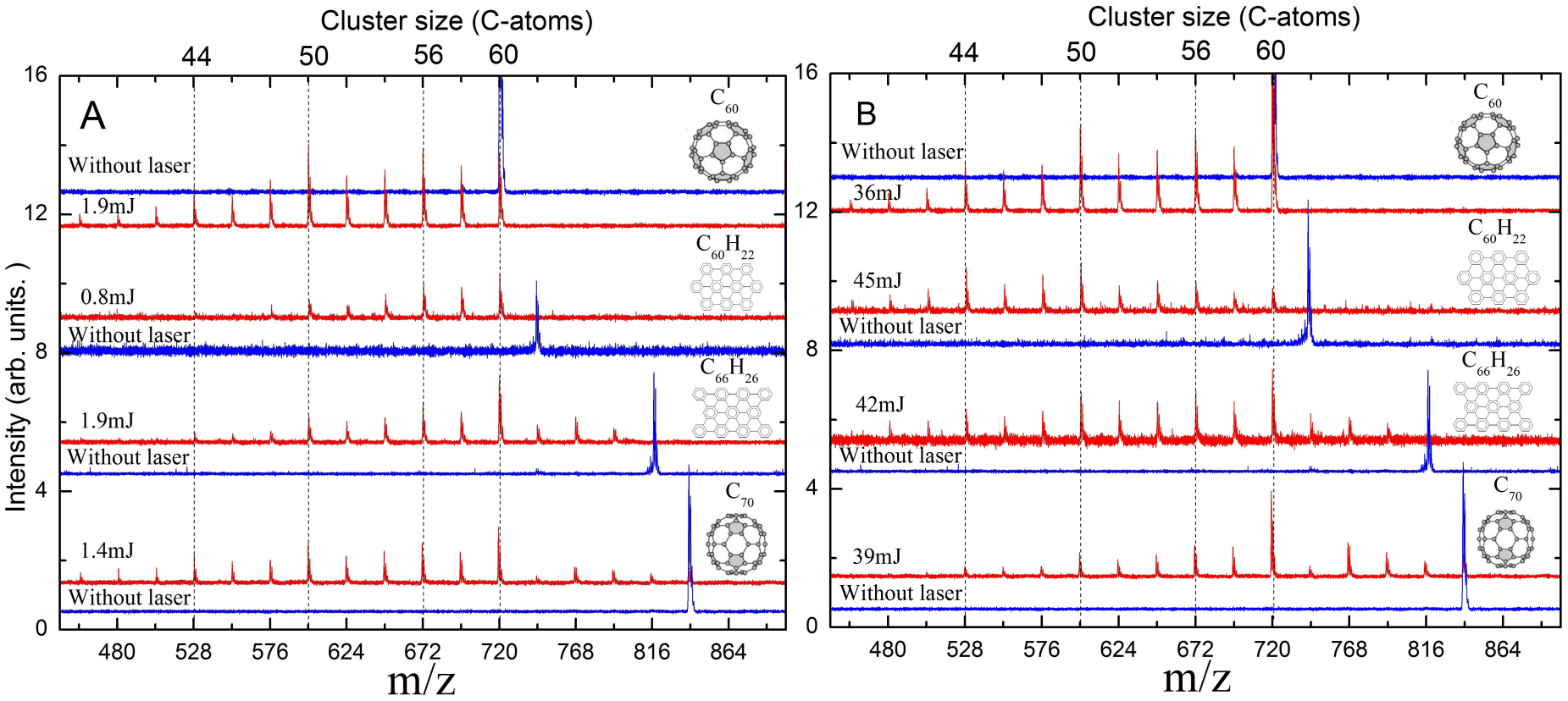
- Dehydrogenation and C_2 loss.
- Compare dissociation patterns.
- C_2 loss necessary for isomerization?



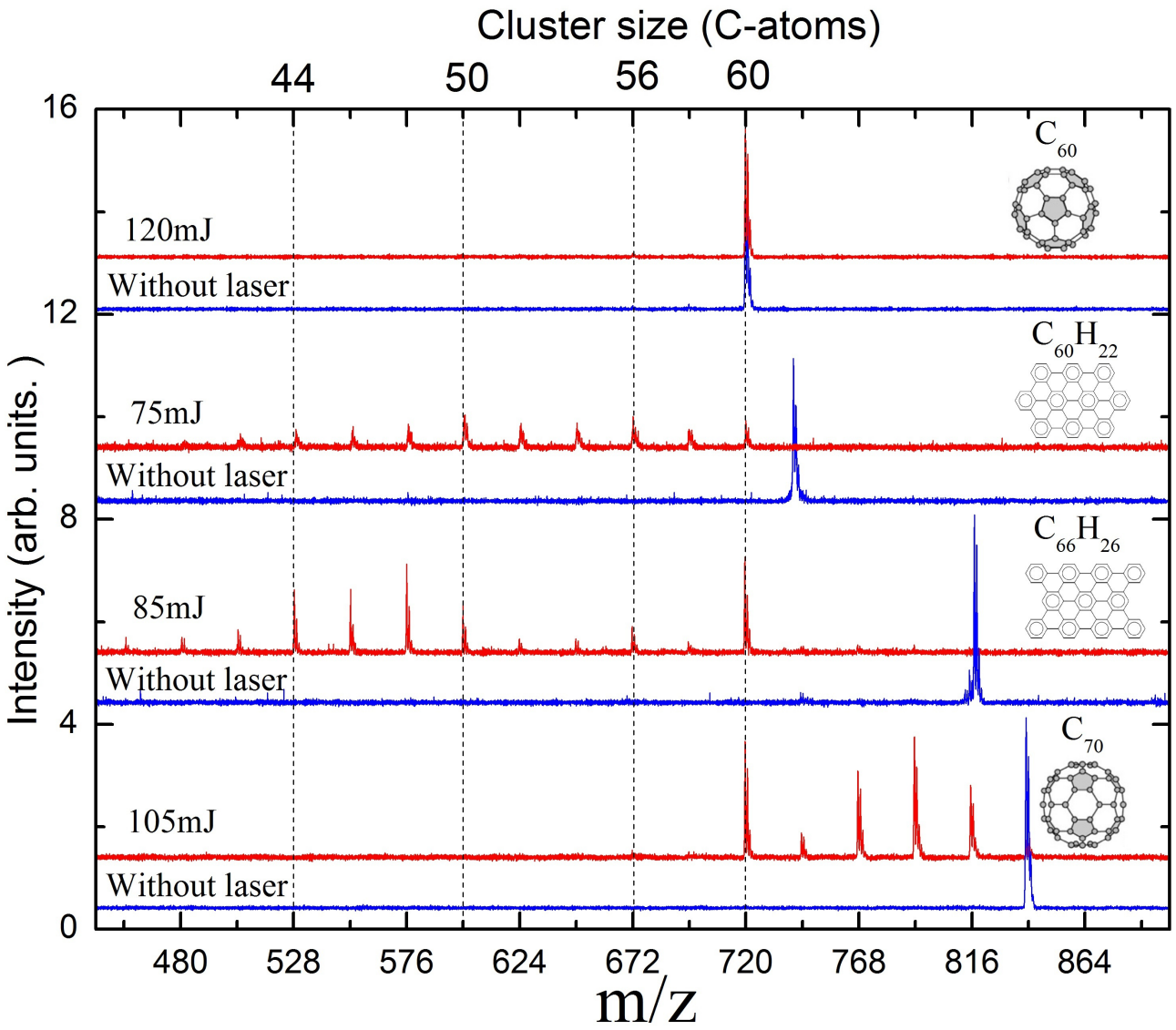
Dehydrogenation



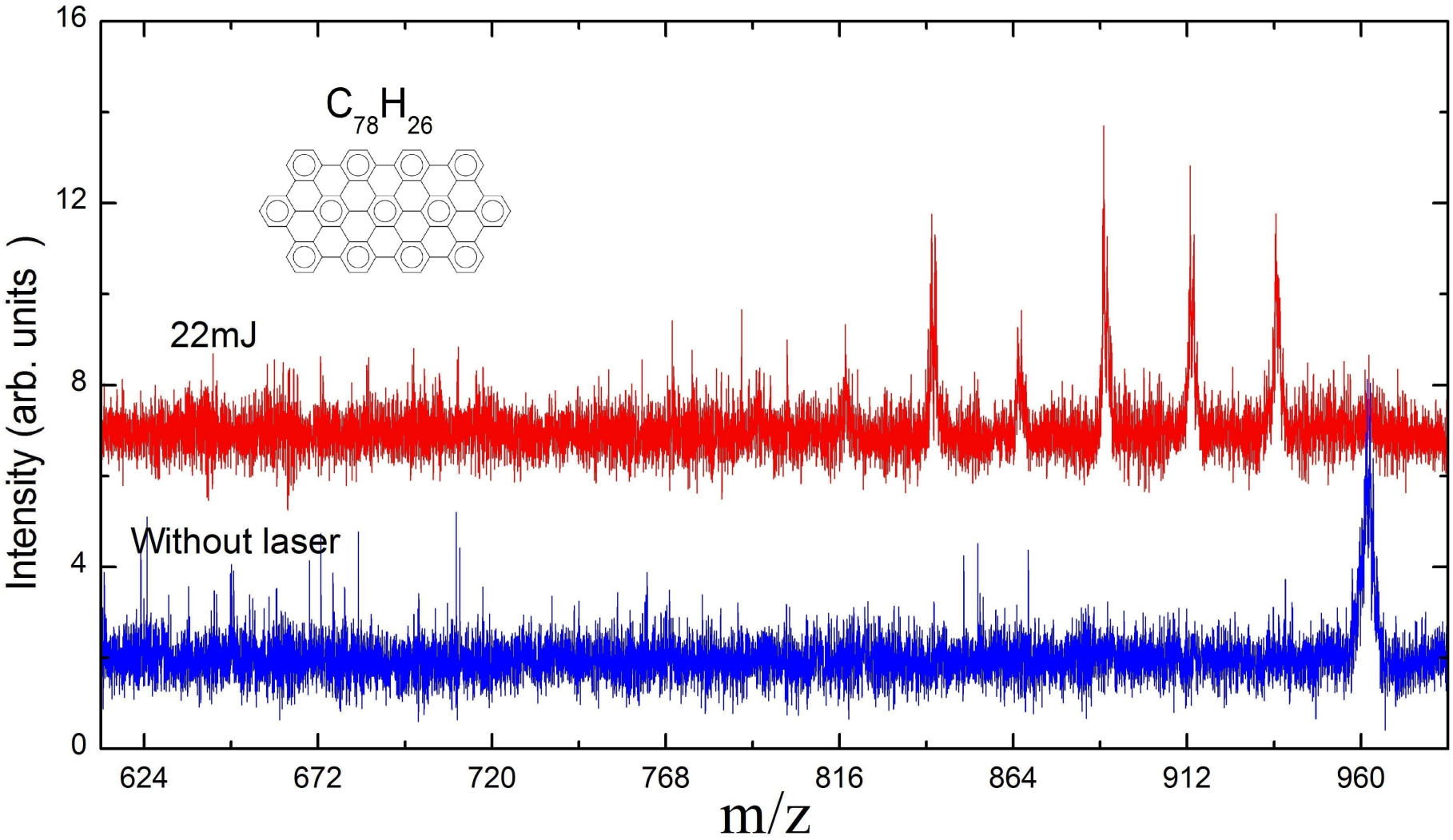
266 and 355 nm Irradiation



532 nm Irradiation



$C_{78}H_{26}$ Fragmentation



Conclusions

- C_{60} can be formed from large PAHs efficiently.
- Large PAHs pass through a first step of fast dehydrogenation.
- C_2 losses are a necessary step for isomerization of closed-cage.
- Smaller (and larger) cages can also be formed.

Future Work:

- Confirmation with IR spectroscopy.
- Derive energies involved using synchrotron radiation.