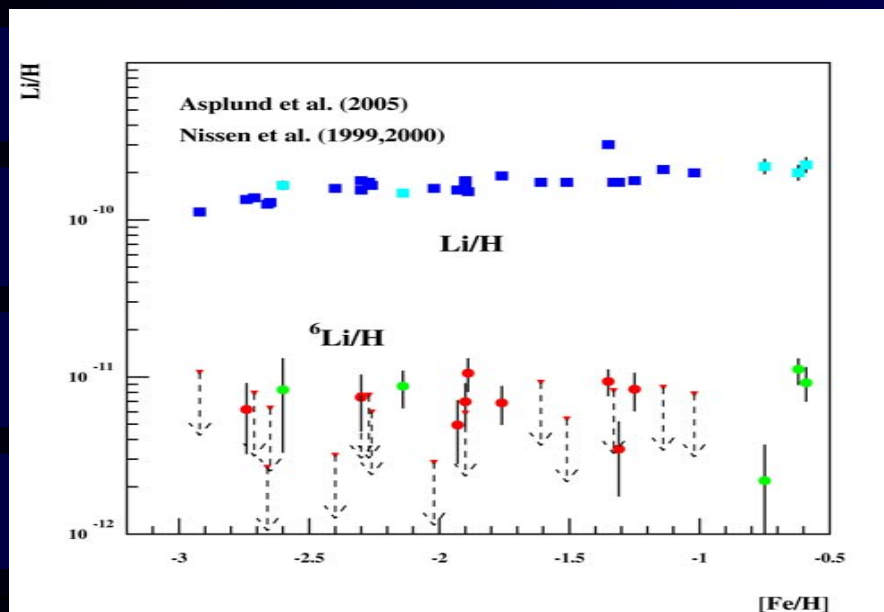


New measurement of the cross section  
of the Big Bang Nucleosynthesis  
reaction  $D(\alpha, \gamma)^6\text{Li}$   
and its astrophysical impact

NIC-IX 2006, CERN (Geneva)

F. Hammache (IPN-Orsay)

# What is the origin of the observed ${}^6\text{Li}$ in old halo stars?

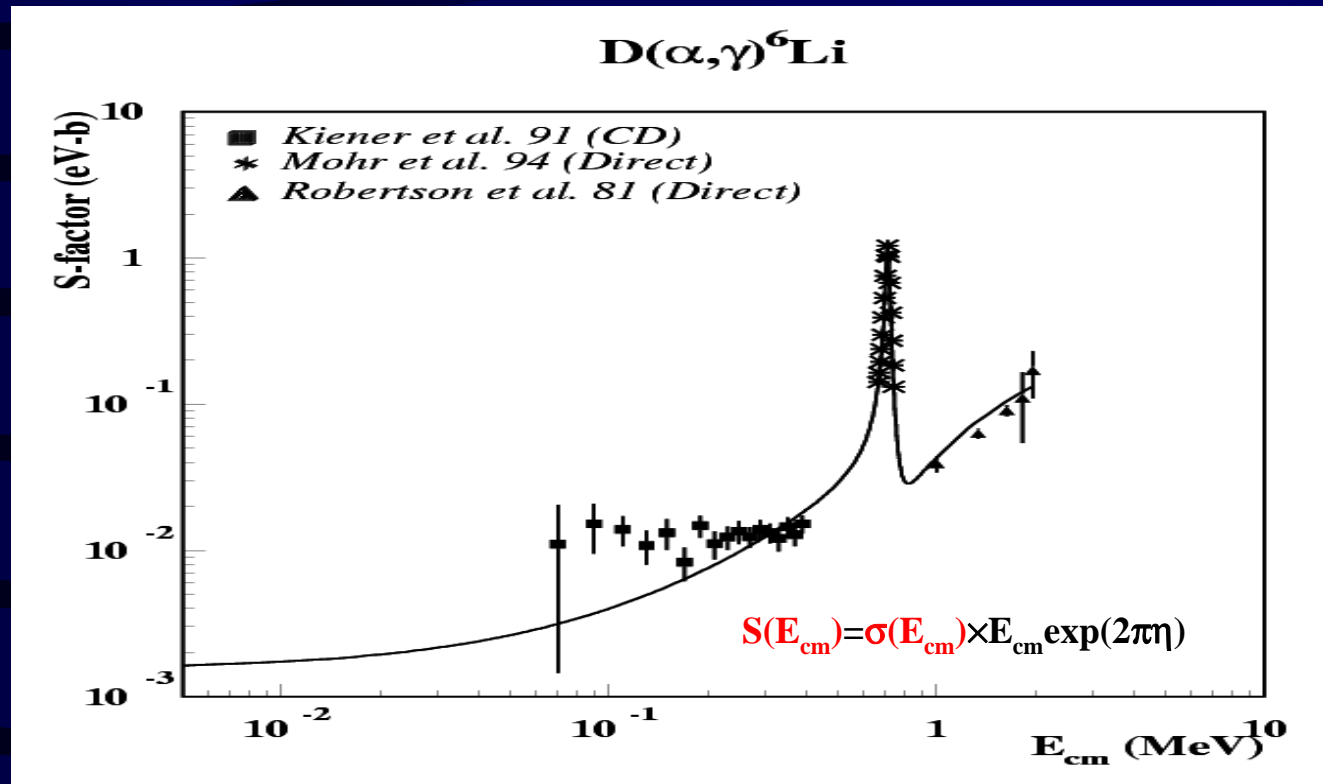


- Primordial?
- Pre-galactic?
- Exotic origin

Primordial  ${}^6\text{Li}$  produced  $\rightarrow \text{D}(\alpha, \gamma){}^6\text{Li}$

**BUT:**  $\Rightarrow$  Huge uncertainty (factor 20) on  ${}^6\text{Li}$  rate (Angulo et al. 99 (NACRE))

$\Rightarrow$  The  $\sigma$  of the reaction  $\text{D}(\alpha, \gamma){}^6\text{Li}$  is badly known @  $E_{c.m.} = 50\text{-}300 \text{ keV}$  ( $T \sim 10^9 \text{ K}$ )



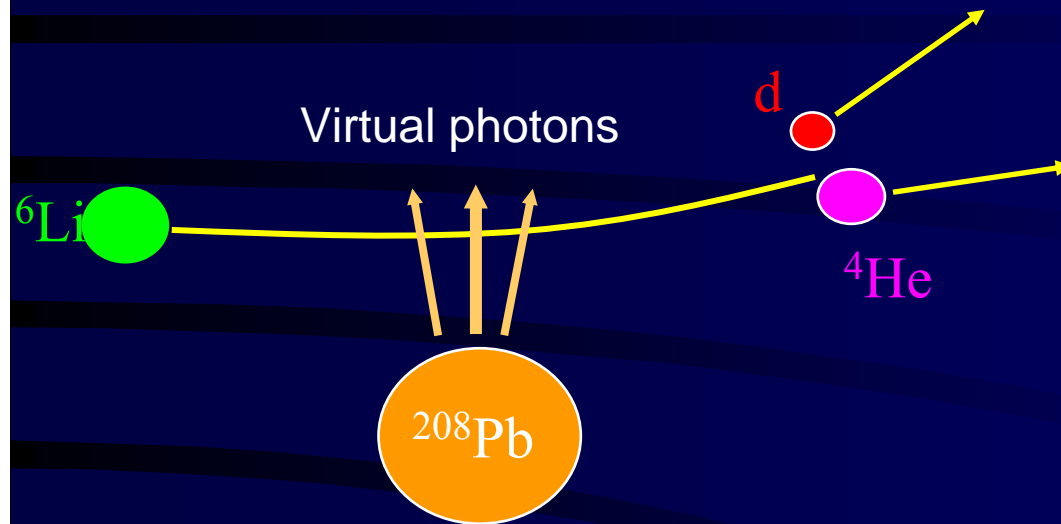
Dominant E2 direct radiative capture of d waves at  $E_{\text{c.m.}} > 110 \text{ keV}$   
 (resonance  $J=3+$  @  $E=711 \text{ keV}$ )

- $50 \text{ keV} \leq E_{\text{c.m.}} \leq 400 \text{ keV} \rightarrow$  Coulomb dissociation measurements of Kiener et al.  $^{208}\text{Pb}(^6\text{Li}, \text{D}+\alpha)^{208}\text{P}$  @  $26 \text{ A.MeV}$

$\rightarrow$  @  $E_{\text{c.m.}} \leq 250 \text{ keV} \rightarrow$  disagreement between Kiener et al. data and the calculations.

## GSI experiment @ Kaos

↙ Coulomb Dissociation of  ${}^6\text{Li}$  @150 A.MeV in  ${}^{208}\text{Pb}$  target of 200 mg/cm<sup>2</sup>



↓ Virtual photon theory

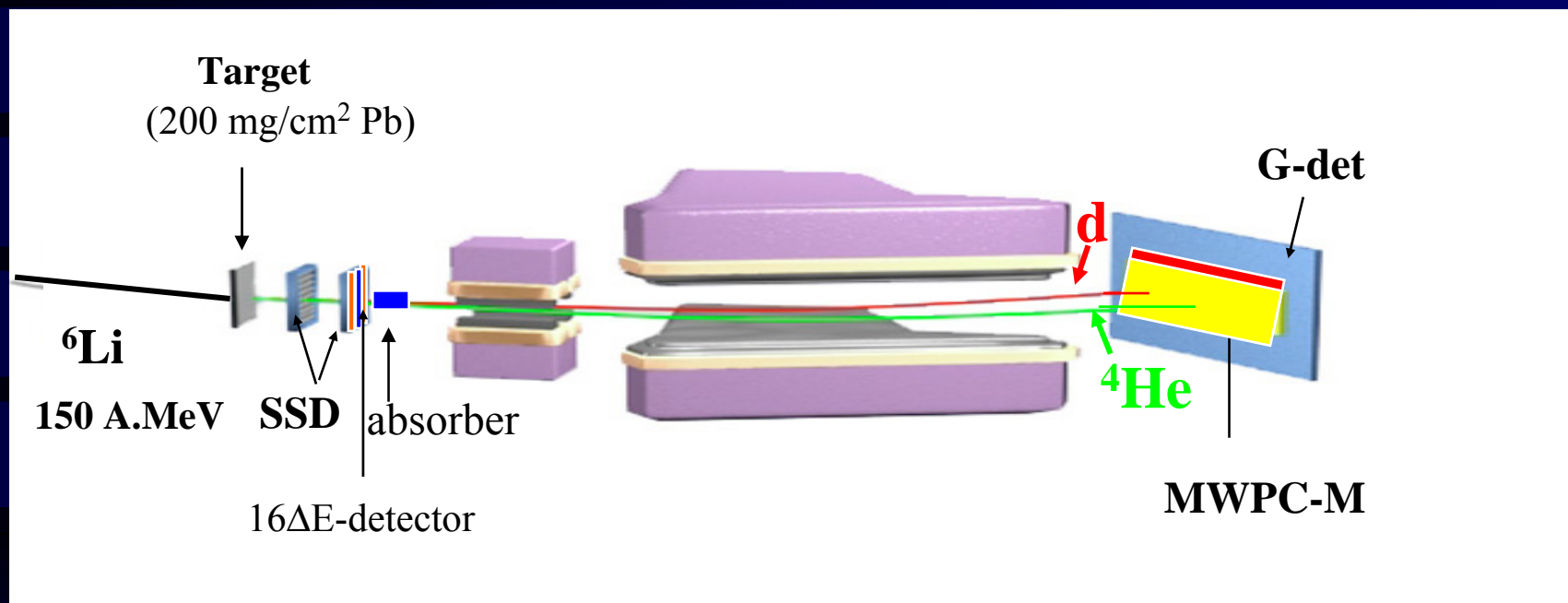


↓ Detailed balance



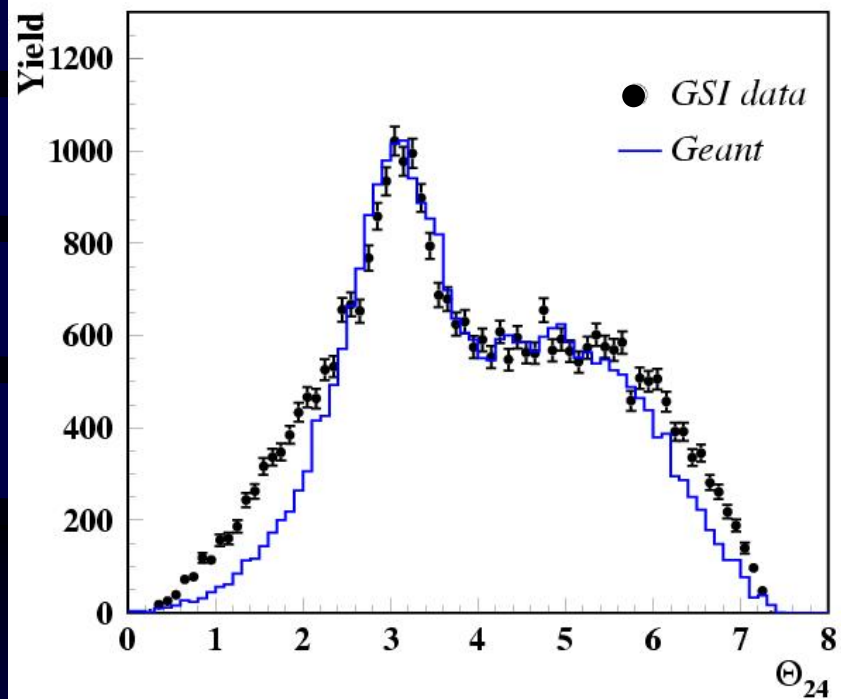
- ⇒ Strong forward-peaked kinematics → more complete angular coverage
- ⇒ The whole energy range from 0.05 to 10 MeV covered at the same time
- ⇒ Coulomb Dissociation is enhanced relative to a possible nuclear background

# *KaoS spectrometer*

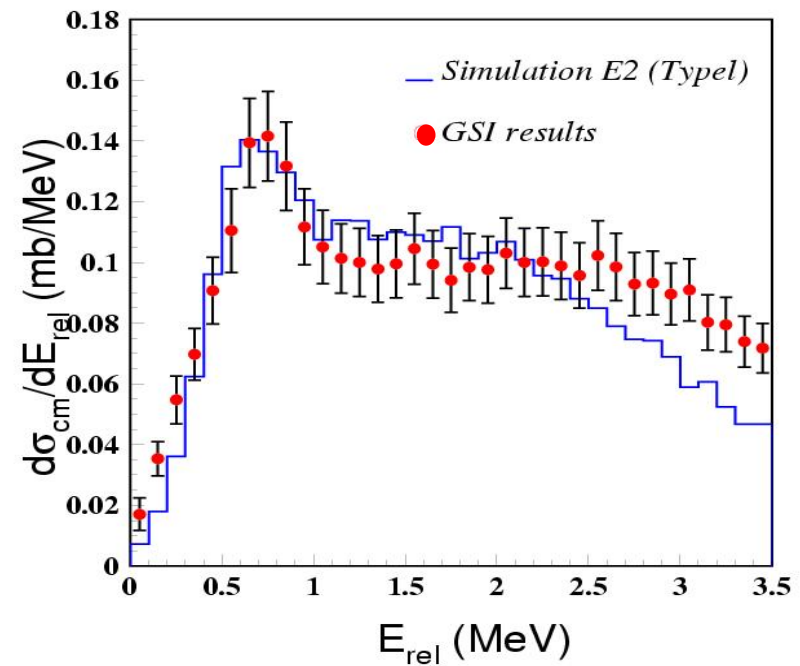


$$E_{\text{rel}} = \sqrt{E_{\text{lab}}^2 - \left( P_{\text{He}}^2 + P_{\text{d}}^2 + 2 \cdot P_{\text{He}} \cdot P_{\text{d}} \cdot \cos(\theta_{24}) \right)} - \left( M_{\text{He}} + M_{\text{d}} \right)$$

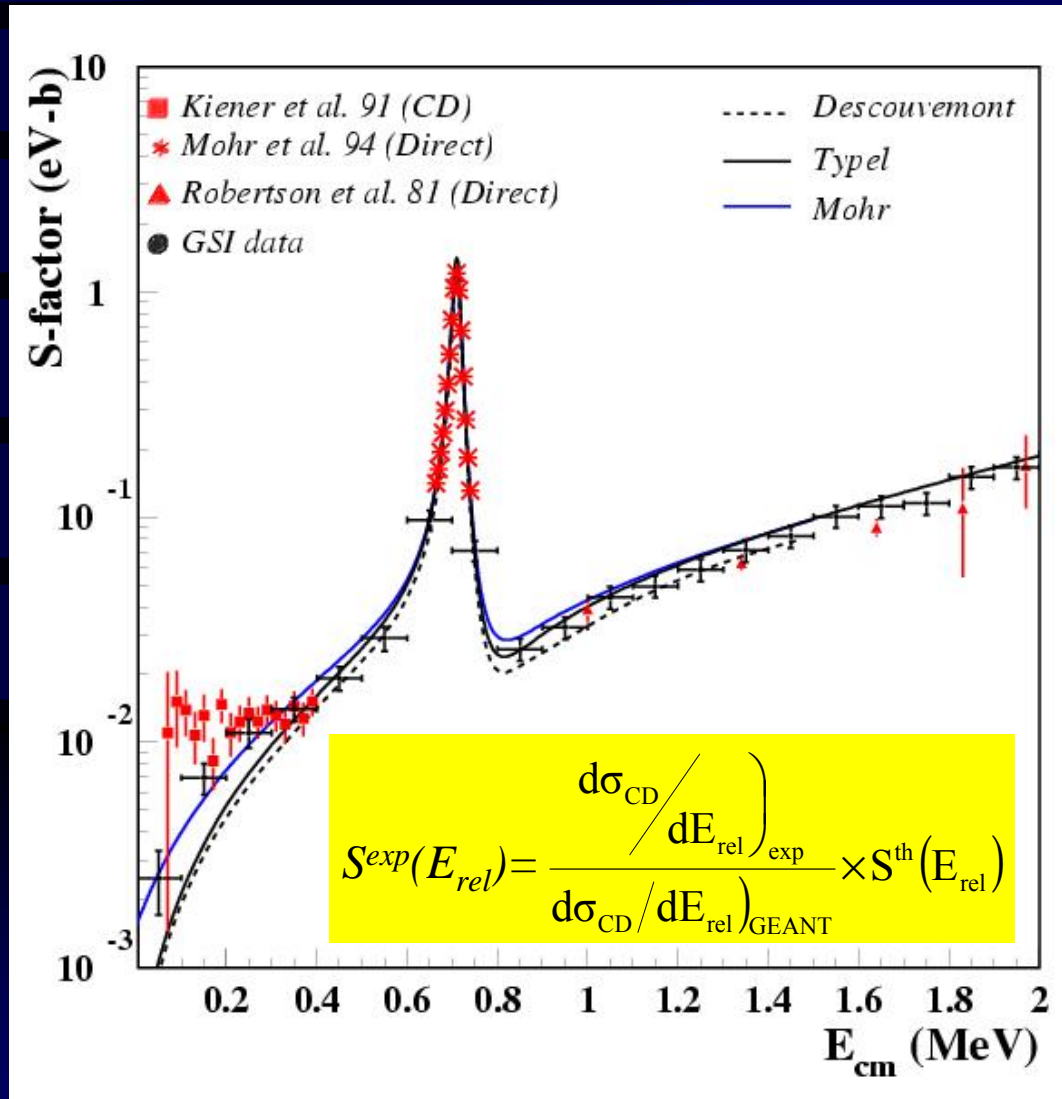
## Opening angle between D and $\alpha$ fragments



## Coulomb Dissociation Differential Cross section



# $D(\alpha, \gamma)^6\text{Li}$ astrophysical S-factors



⇒ Good agreement with direct data of Mohr et al. & Robertson et al.

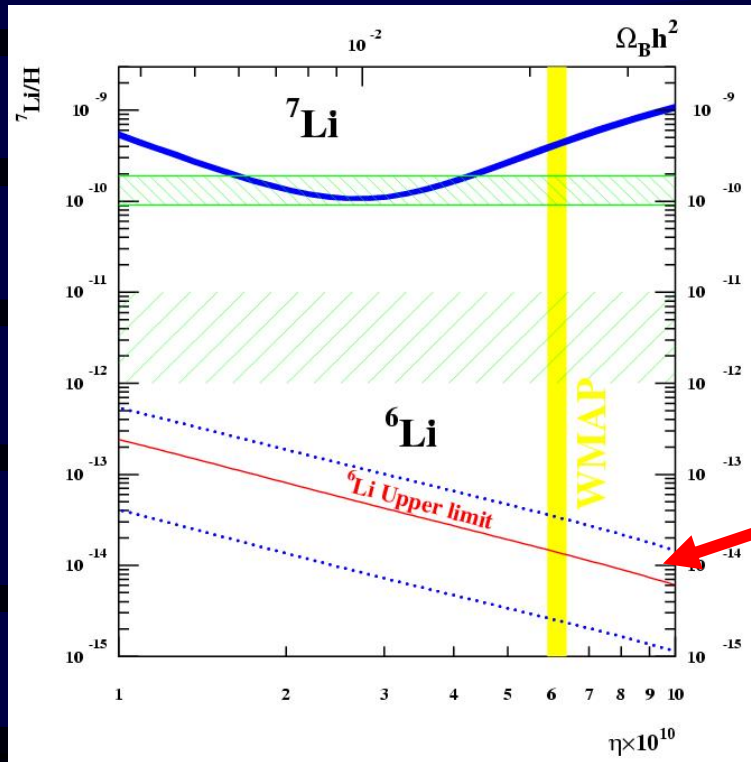
⇒ Disagreement with Kiener et al. data at  $E_{\text{cm}} \leq 200 \text{ keV}$

⇒ Good agreement with E2 Typel & Descouvemont calculations at  $E_{\text{cm}} \geq 300 \text{ keV}$  & with E2 Mohr calculation



GSI S-factors decrease when the energy is decreasing  $\cong$  model predictions

# New ${}^6\text{Li}/\text{H} = f(\eta)$

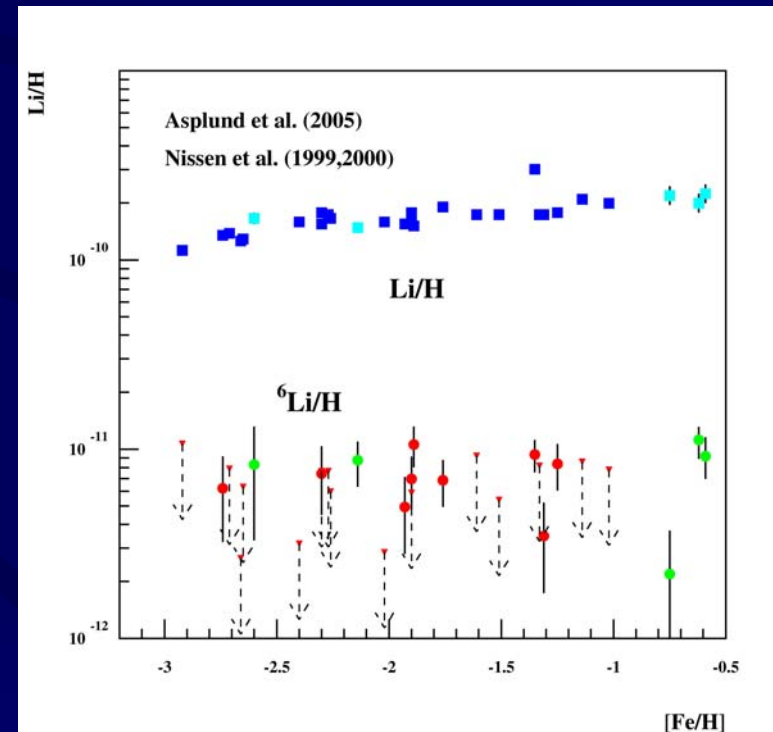


Introduction of the **new GSI  ${}^6\text{Li}$  rate** in the BBN model of Coc et al.(04)

☞ **WMAP results** → primordial  ${}^6\text{Li}/\text{H} = 10^{-14}$

☞ Asplund et al. (2005) **observations of a  ${}^6\text{Li}$  plateau** → → →

☞ **New cosmologic challenge** (Rollinde et al.(05))





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