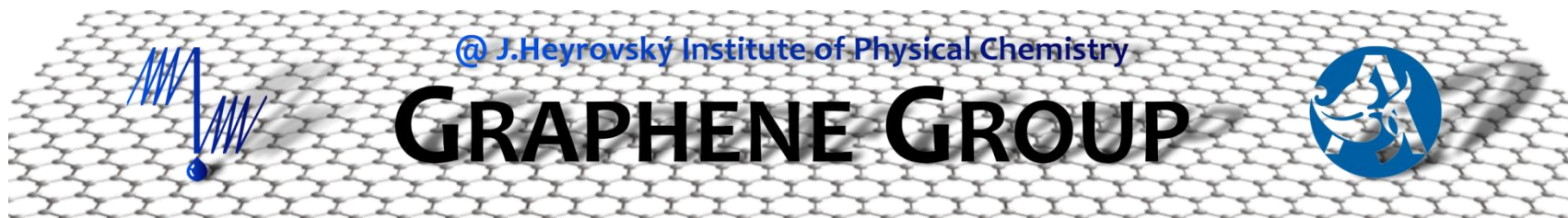


Martin Kalbáč

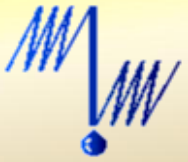
martin.kalbac@jh-inst.cas.cz

Ústav fyzikální chemie J. Heyrovského AV ČR, v.v.i.

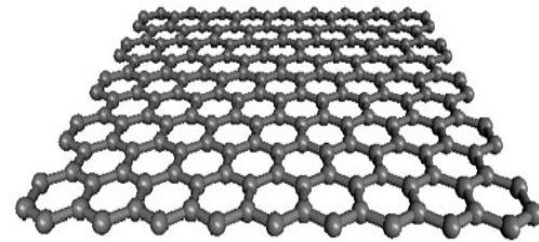
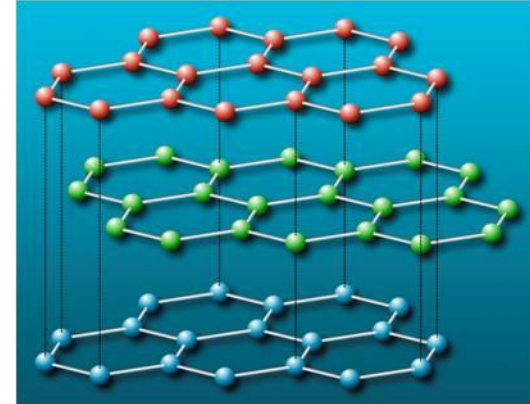
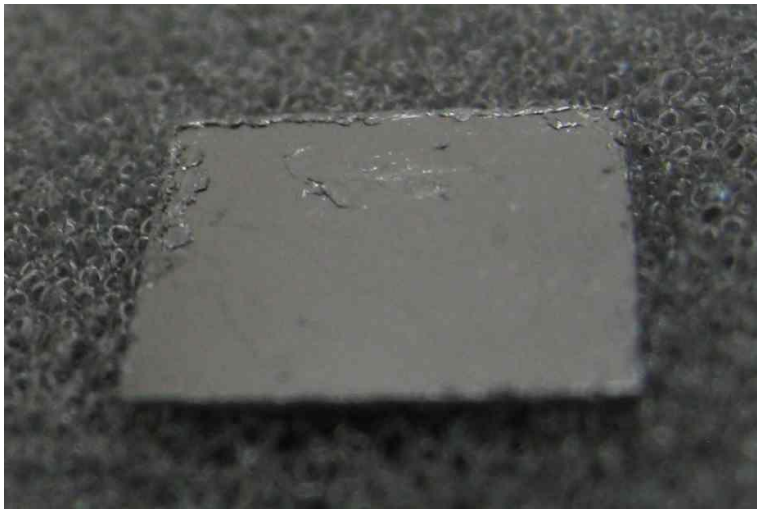
www.nanocarbon.cz

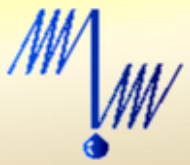


What is graphene ?



Graphite



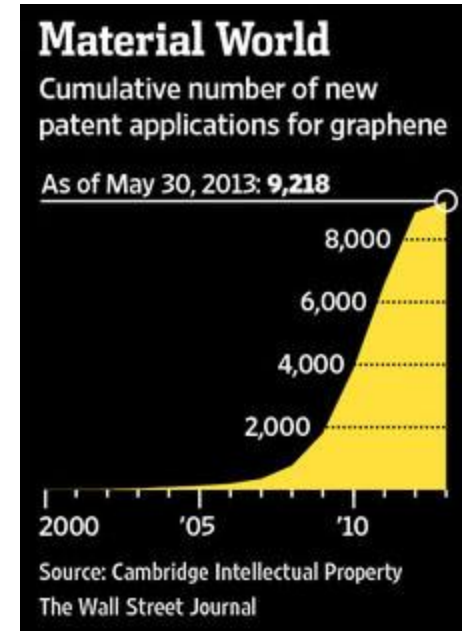


Patents related to carbon nanostructures

Fullerenes 13000 (1985)

Carbon nanotubes 30000 (1991)

Graphene 9000 (2004)



Graphene @JHIPC



**CVD
Synthesis**

**Isotope
labeling**

**Thermal
properties**

Functionalization

Doping

Raman spectroscopy, AFM, SEM , etc.

Sensors

Electronics

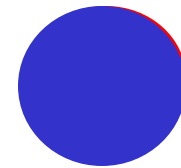
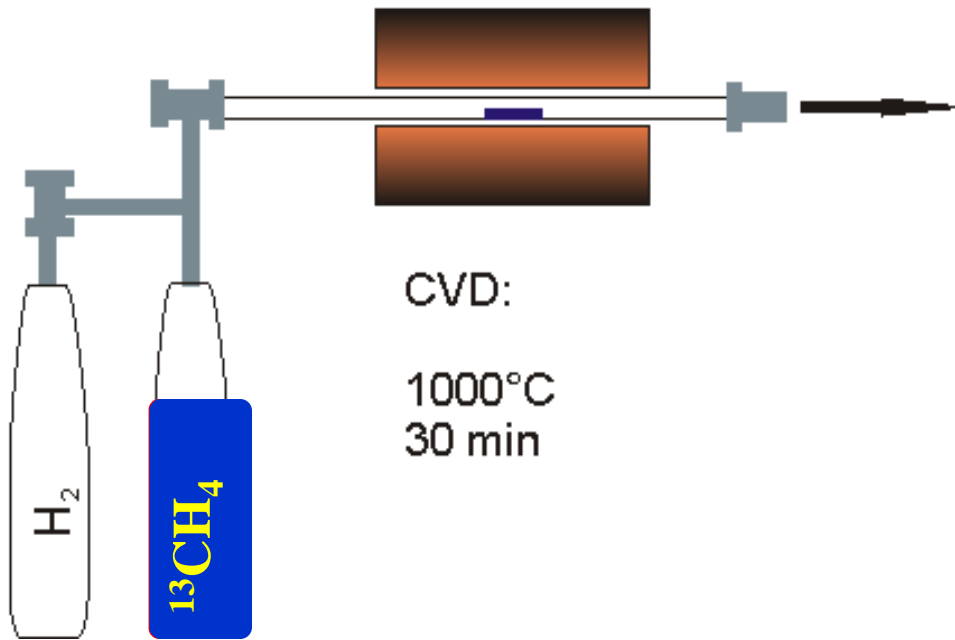
Preparation

Fundamental study

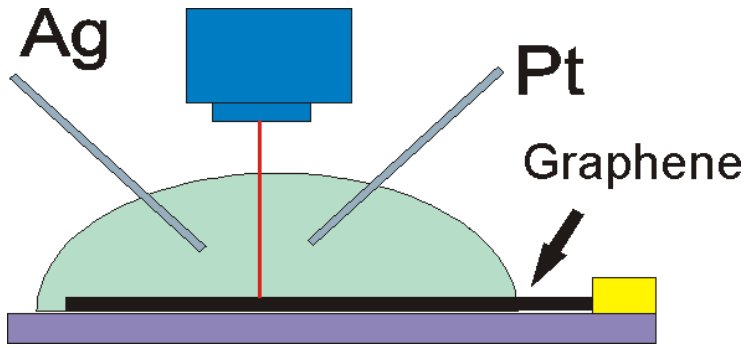
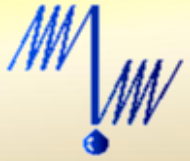
Application



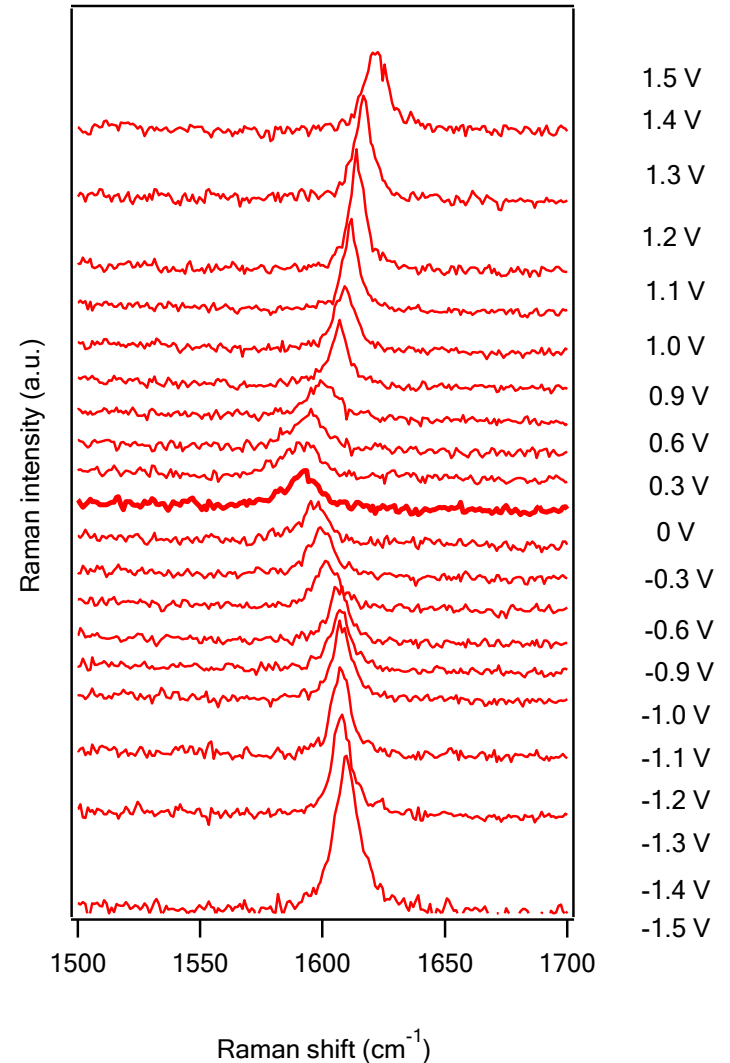
Isotope labeling

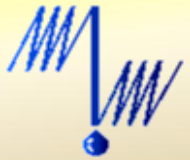


Doping of graphene



$$E_{\text{laser}} = 1.92 \text{ eV}$$





Why is Graphene is good for application in electronics?

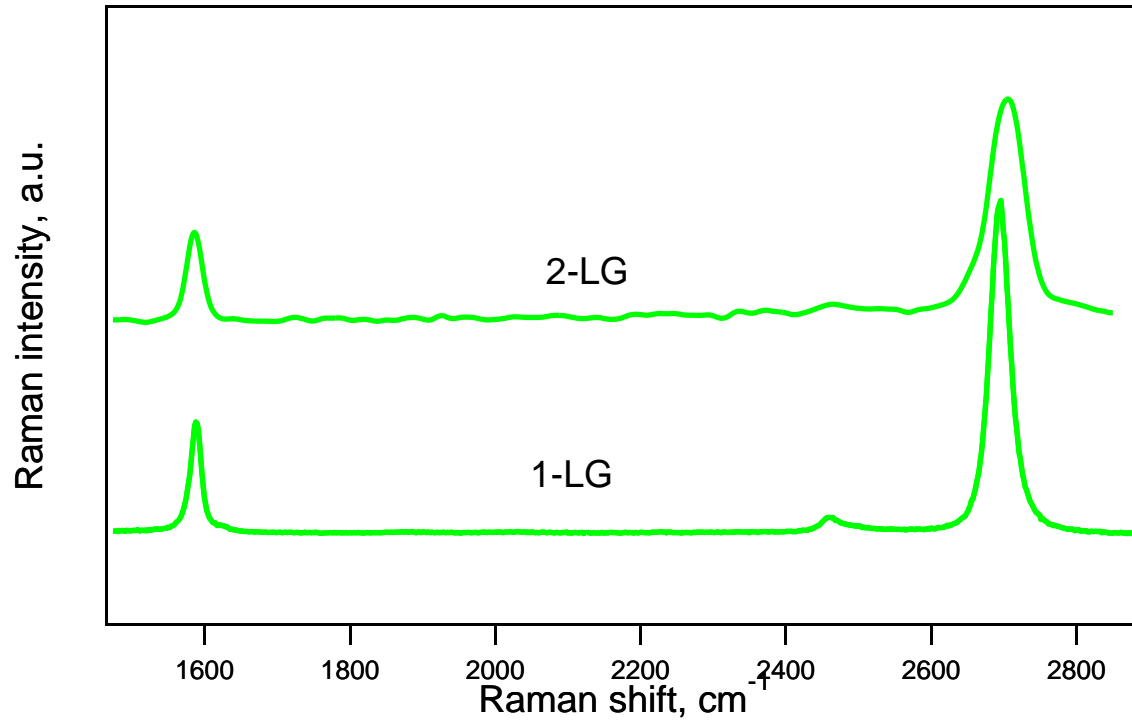
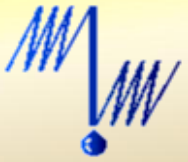
- Good thermal conductivity –thermal management
- Small size – density of transistors can be high
- Fast switching- high frequency electronics
- Good electrical conductivity –construction of leads
- New type of electronic devices



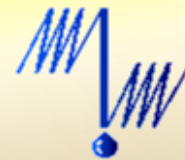
Towards a „Green“ transistor

- New type of transistor
- 1000 times less energy consumption than MOSFET
- Can be made from non/weakly-interacting graphene layers

Raman spectrum of 1-LG vs. 2-LG

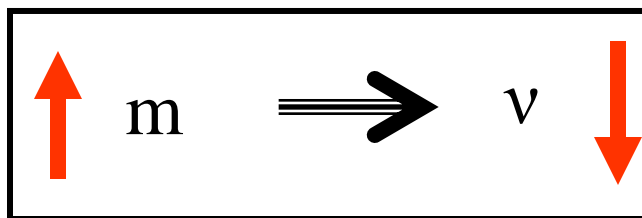
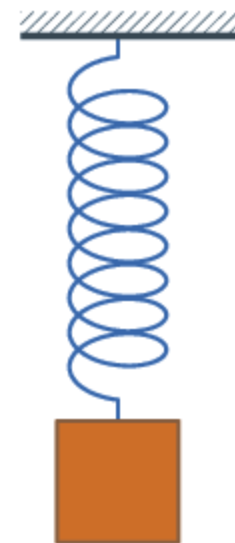


Isotope labeling in the study of carbon nanostructures

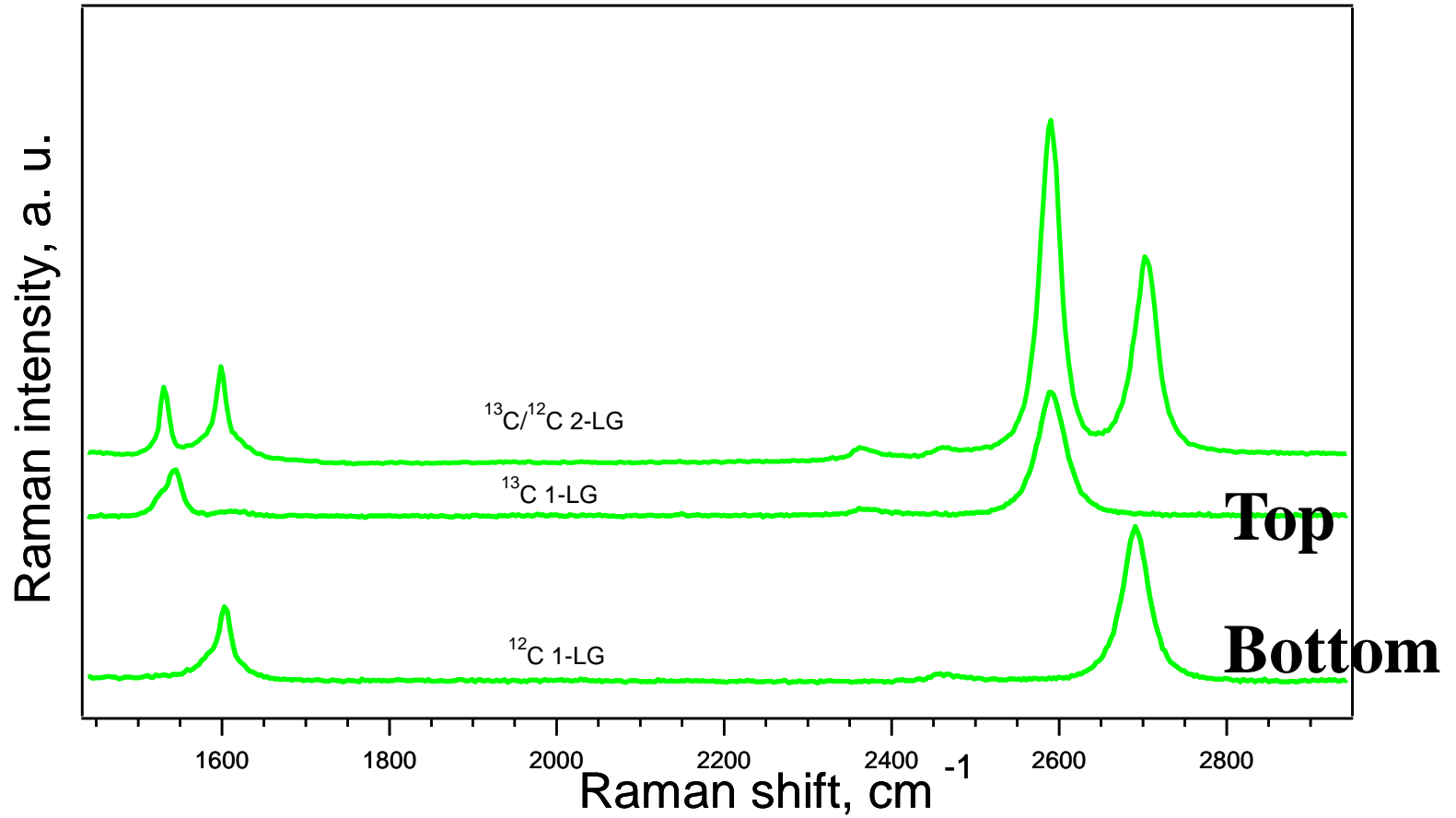
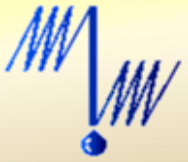


$$\frac{(\nu_0 - \nu)}{\nu_0} = 1 - \left[\frac{12 + c_0}{12 + c} \right]^{1/2}$$

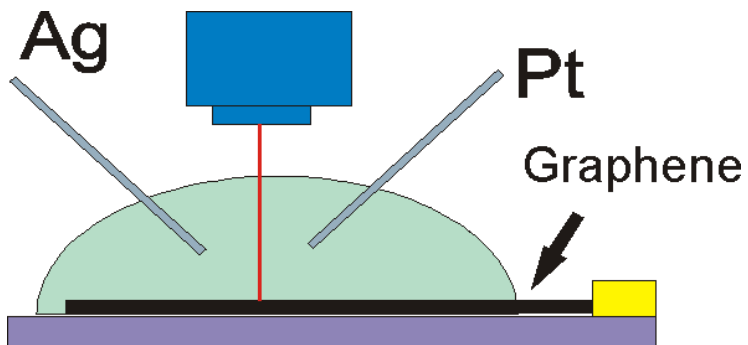
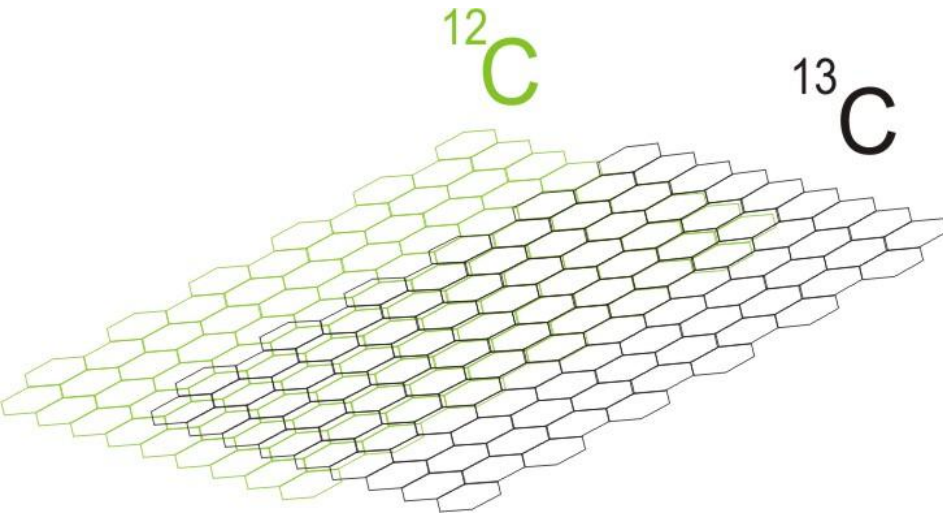
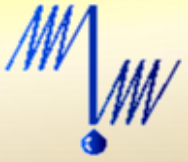
- ν_0 - frequency of particular mode in Nat-C sample
- c - concentration of ^{13}C in enriched sample
- $c_0 = 0.011$ is the natural abundance of ^{13}C .



Isotope labeling in 2-LG

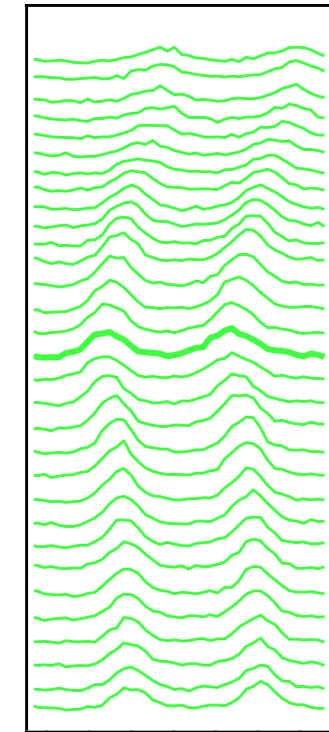


Doping of 2-LG

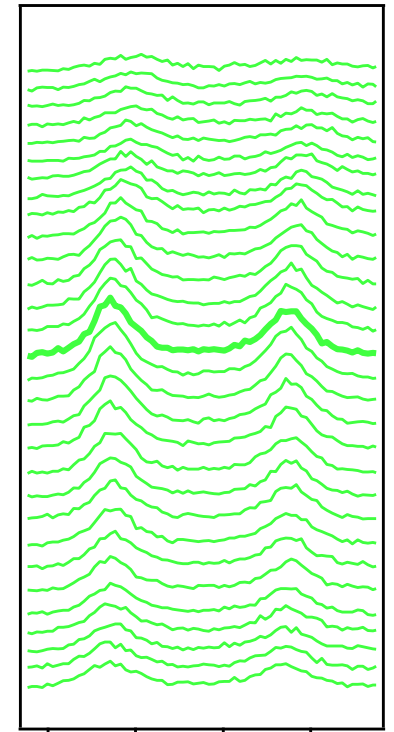


2-LG

Raman intensity, a.u.



Raman shift, cm^{-1}



Raman shift, cm^{-1}