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Helium Alignment Energy Coinciding Helium Superfluidity (On the Microscopic Andronikashvili Experiment)

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Abstract: *Significantly low cluster alignment energy of 59 helium atoms coincides with the appearance of helium superfluidity.*

Keywords: *Alignment energy of helium clusters, helium superfluidity*

1. Introduction

Grebenev et al [1] measured the infrared spectrum of single oxygen carbon sulfide (OCS) molecules inside large superfluid pure helium-4 droplets and nonsuperfluid pure helium-3 droplets, both consisting of about 10^4 atoms. In the helium-4 droplets, sharp rotational lines were observed, whereas in helium-3 only a broad peak was found. This difference is interpreted as evidence that the narrow rotational lines, which imply free rotations, are a microscopic manifestation of superfluidity. Upon addition of 60 helium-4 atoms to the pure helium-3 droplets, the same sharp rotational lines were found; it appears that 60 is the minimum number needed for superfluidity. Let's see if this number has anything to do with alignment energy of helium clusters.

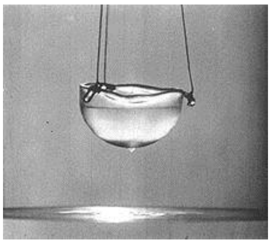

Figure1. *Superfluidity [2]*

2. The Alignment Energy

The alignment energy of the atom or molecule and even cluster enables the alignment of the electron with its atom or molecule or cluster nature [3], [4],[5],[6],[7],[8],[9],[10],[11],[12]. Next formula should be applicable also for helium atom He and its clusters $(He)_n$:

$$Wk_{alignment} = \left(\frac{R_{unaligned}}{R_{aligned}} - 1\right) m^{rest}_{electron} c^2. \tag{1}$$

Where $R_{unaligned}$ in our present case is the unaligned modified ratio of helium-4 atom or its cluster mass to electron mass:

$$R_{unaligned} = \frac{m_{atom\ or\ cluster}}{m^{rest}_{electron}} s(1). \tag{2}$$

The rest mass of the electron can be expressed in daltons (Da), i.e. $m^{rest}_{electron} = 0{,}00054857990907$ Da. The factor s(1) = 1,696 685 529… is the average elliptic-hyperbolic manifestation of one (n = 1) elliptic Compton wavelength of the electron given by the next equation:

$$s(n) = n\left(2 - \frac{1}{\sqrt{1+\frac{\pi^2}{n^2}}}\right), n \in \mathbb{N}. \tag{3}$$

And the aligned modified ratio $R_{aligned}$ is given by the same equation (3) for the down rounded unaligned modified ratio (n=*ROUNDDOWN* ($R_{unaligned}$)) as follows:

$$R_{aligned} = s\left(\mathrm{ROUNDDOWN}(R_{unaligned})\right). \qquad (4)$$

3. The Helium Alignment Energies

Using the data from the reference [13], [14] and applying the equations (1), (2), (3), (4) the alignment energies of helium isotope He-4 having mass 4,00260325413 Da and its sixty clusters $(He\text{-}4)_n$ have been calculated and presented in Table 1.

Table1. *First sixty alignment energies of helium-4 isotope and its clusters*

Helium-4	Alignment energy (eV)	Helim-4	Alignment energy (eV)	Helim-4	Alignment energy (eV)	Helim-4	Alignment energy (eV)
He	21,679403872	(He)16	1,056002636	(He)31	0,390277760	(He)46	0,158714632
(He)2	1,051953289	(He)17	2,270069320	(He)32	1,056050843	(He)47	0,616933036
(H)3	7,933984456	(He)18	1,056016126	(He)33	0,430629543	(He)48	0,196104558
(He)4	1,055038506	(He)19	2,142284683	(H)e34	1,056052678	(He)49	0,634857144
(He)5	5,183234023	(He)20	1,056025776	(He)35	0,466369594	(He)50	0,230503271
(He)6	1,055609842	(He)21	0,073223880	(He)36	1,056054216	(He)51	0,651375420
(He)7	4,004170943	(He)22	1,056032915	(He)37	0,498245777	(He)52	0,262255913
(He)8	1,055809810	(He)23	0,158722395	(He)38	1,056055517	(He)53	0,666647015
(He)9	3,349091816	(He)24	1,056038345	(He)39	0,526858139	(He)54	0,291656493
(He)10	1,055902367	(He)25	0,230483526	(He)40	0,024110721	(He)55	0,680807933
(He)11	2,932206886	(He)26	1,056042571	(He)41	0,552668355	(He)56	0,318957020
(He)12	1,055952645	(He)27	0,291639565	(He)42	0,073251864	(He)57	0,693975090
(He)13	2,643586773	(He)28	1,056045924	(He)43	0,576082654	(He)58	0,344374742
(He)14	1,055982960	(He)29	0,344360068	(He)44	0,117925598	(He)59	0,006625705
(He)15	2,431928139	(He)30	1,056048629	(He)45	0,597415646	(He)60	0,368097940

Taking into account the data in Table1 we can conclude that respecting our concept instead of 60 helium atoms already 59 of them would probably be enough to achieve superfluidity of helium due to sufficiently low alignment energy of $(He)_{59}$ cluster yielding only 0.0066 eV. After all this is the lowest alignment energy between first sixty Helium-4 clusters. The characteristics of Helium alignment energies are shown in Figure 2, too. They express the trend of being in inverse proportion with the number of atoms in cluster although they manifest typical zig-zag fluctuations. With other words, an infinite cluster should have zero alignment energy but of course there is no straight path to infinity.

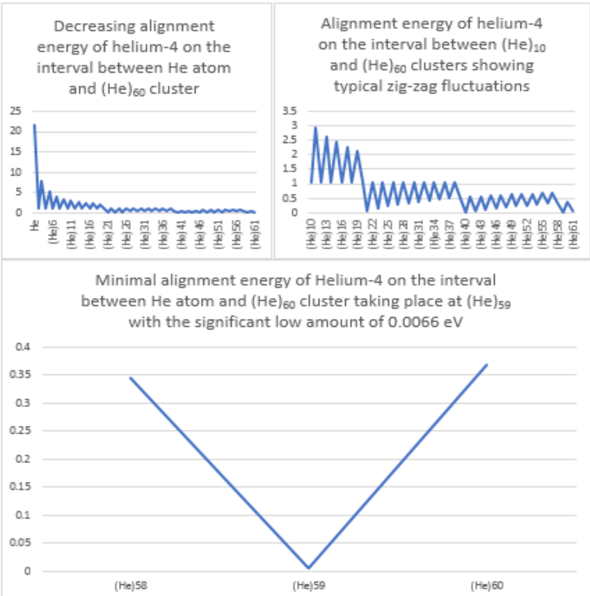

Figure2. *Some characteristics of Helium alignment energies.*

4. Conclusion

Not only “What?” but also “How many?” is important

5. Dedication

To Paracelsus and his statement that “The dosage distinguishes between poison and remedy”

References

[1] Grebenev S, Toennies JP, Vilesov AF. Superfluidity within a small helium-4 cluster: the microscopic andronikashvili experiment. Science. 1998 Mar 27;279(5359):2083-6. doi: 10.1126/science.279.5359.2083. PMID: 9516103.

[2] https://en.wikipedia.org/wiki/Superfluidity

[3] Špringer J. Double Surface and Fine Structure. Progress in Physics, 2013, v. 2, 105–106.

[4] Janez Špringer (2021). Whole and Part in Hydrogen Atom. International Journal of Advanced Research in Physical Science (IJARPS) 8(5), pp.1-3, 2021.

[5] Janez Špringer (2021). Whole and Part in Helium. International Journal of Advanced Research in Physical Science (IJARPS) 8(5), pp.4-8, 2021.

[6] Janez Špringer (2021). Gap Energy in Hydrogen and Helium. International Journal of Advanced Research in Physical Science (IJARPS) 8(5), pp.12-15, 2021

[7] Janez Špringer (2021). Gold Gap Energy. International Journal of Advanced Research in Physical Science (IJARPS) 8(6), pp.1-3, 2021.

[8] Janez Špringer (2021). Oxygen Alignment Energy at Water Splitting. International Journal of Advanced Research in Physical Science (IJARPS) 8(6), pp.10-12, 2021.

[9] Janez Špringer (2021). Bromine speed at Translationally Cold Circumstances. International Journal of Advanced Research in Physical Science (IJARPS) 8(7), pp.1-3, 2021.

[10] Janez Špringer (2021). Hydrogen Alignment Energy and Liquid-Liquid Critical Point. International Journal of Advanced Research in Physical Science (IJARPS) 8(7), pp.15-17, 2021.

[11] Janez Špringer (2021). Water Alignment Energy and Liquid-Liquid Critical Point. International Journal of Advanced Research in Physical Science (IJARPS) 8(8), pp.13-16, 2021.

[12] Janez Špringer (2021) “Birds of a Feather Flock Together (On the Similarity of Gold and Phosphorus Alignment Energies)”. International Journal of Advanced Research in Physical Science (IJARPS) 8(9), pp.1-4, 2021.

[13] CODATA, retrieved July 2021

[14] Exact Masses of the Elements, Isotopic Abundances of Elements (sisweb.com), retrieved July 2021

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