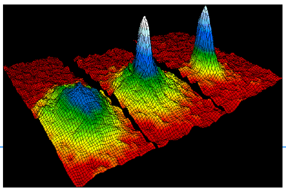
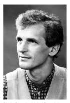
Condensados de Bose-Eisntein



The Nobel Prize in Physics 2001

Photo from the Nobel Foundation archive.
Eric A. Cornell
Prize share: 1/3



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Wolfgang Ketterle
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Carl E. Wieman
Prize share: 1/3

VOLUME 75 27 NOVEMBER 1995 NUMBER 22

Bose-Einstein Condensation in a Gas of Sodium Atoms

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(Received 17 October 1995)

We have observed Bose-Einstein condensation of sodium atoms. The atoms were trapped in a novel trap that employed both magnetic and optical forces. Evaporative cooling increased the phase-space density by 6 orders of magnitude within seven seconds. Condensates contained up to 5×10^5 atoms at densities exceeding 10^{14} cm^{-3}. The striking signature of Bose condensation was the sudden appearance of a bimodal velocity distribution below the critical temperature of $\sim 2\ \mu$K. The distribution consisted of an isotropic thermal distribution and an elliptical core attributed to the expansion of a dense condensate.

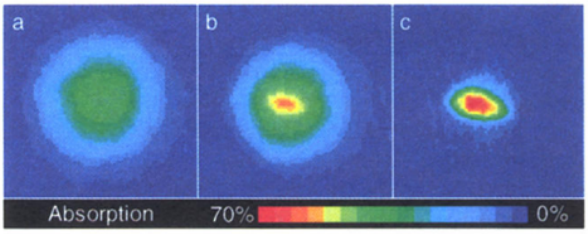
PACS numbers: 03.75.Fi, 05.30.Jp, 32.80.Pj, 64.60.–i

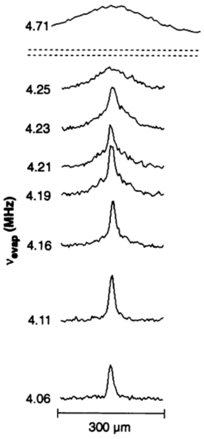
REPORTS

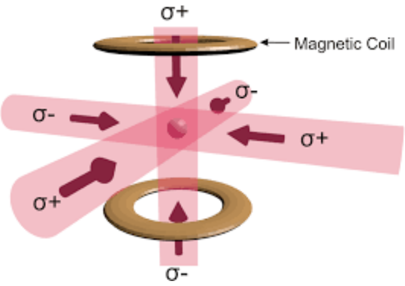
Observation of Bose-Einstein Condensation in a Dilute Atomic Vapor

M. H. Anderson, J. R. Ensher, M. R. Matthews, C. E. Wieman,*
E. A. Cornell

A Bose-Einstein condensate was produced in a vapor of rubidium-87 atoms that was confined by magnetic fields and evaporatively cooled. The condensate fraction first appeared near a temperature of 170 nanokelvin and a number density of 2.5×10^{12} per cubic centimeter and could be preserved for more than 15 seconds. Three primary signatures of Bose-Einstein condensation were seen. (i) On top of a broad thermal velocity distribution, a narrow peak appeared that was centered at zero velocity. (ii) The fraction of the atoms that were in this low-velocity peak increased abruptly as the sample temperature was lowered. (iii) The peak exhibited a nonthermal, anisotropic velocity distribution expected of the minimum-energy quantum state of the magnetic trap in contrast to the isotropic, thermal velocity distribution observed in the broad uncondensed fraction.







VOLUME 75, NUMBER 9 PHYSICAL REVIEW LETTERS 28 AUGUST 1995

Evidence of Bose-Einstein Condensation in an Atomic Gas with Attractive Interactions

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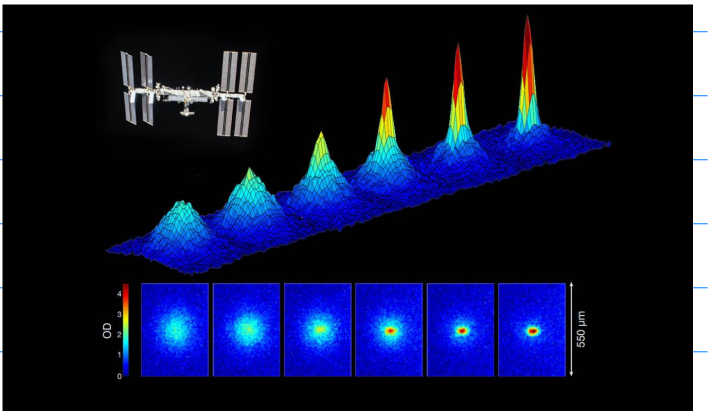
(Received 25 July 1995)

Evidence for Bose-Einstein condensation of a gas of spin-polarized ^{7}Li atoms is reported. Atoms confined to a permanent-magnet trap are laser cooled to 200 μK and are then evaporatively cooled to lower temperatures. Phase-space densities consistent with quantum degeneracy are measured for temperatures in the range of 100 to 400 nK. At these high phase-space densities, diffraction of a probe laser beam is observed. Modeling shows that this diffraction is a sensitive indicator of the presence of a spatially localized condensate. Although measurements of the number of condensate atoms have not been performed, the measured phase-space densities are consistent with a majority of the atoms being in the condensate, for total trap numbers as high as 2×10^5 atoms. For ^{7}Li, the spin-triplet *s*-wave scattering length is known to be negative, corresponding to an attractive interatomic interaction. Previously, Bose-Einstein condensation was predicted not to occur in such a system.

PACS numbers: 03.75.Fi, 05.30.Jp, 32.80.Pj



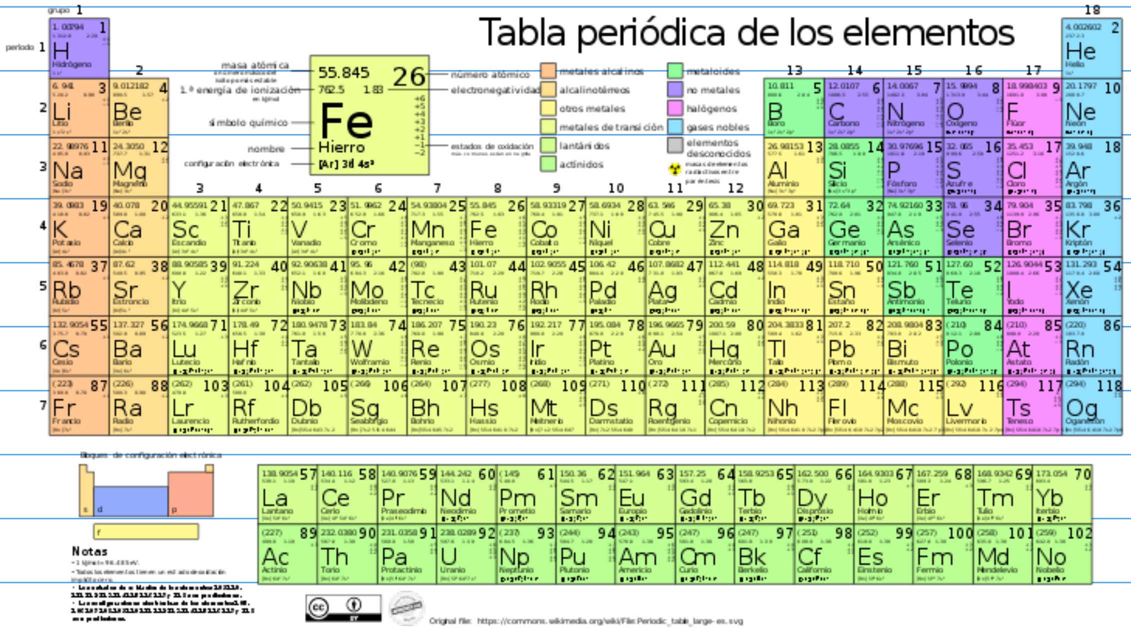


Tabla periódica de los elementos

- 🟧 metales alcalinos
- 🟧 alcalinotérreos
- 🟨 otros metales
- 🟨 metales de transición
- 🟩 lantánidos
- 🟩 actínidos
- 🟩 metaloides
- 🟪 no metales
- 🟪 halógenos
- 🟦 gases nobles
- ⬜ elementos desconocidos
- ☢ masas de elementos radiactivos entre paréntesis

periodo \ grupo	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hidrógeno 1.00794																	2 He Helio 4.002602
2	3 Li Litio 6.941	4 Be Berilio 9.012182											5 B Boro 10.811	6 C Carbono 12.0107	7 N Nitrógeno 14.0067	8 O Oxígeno 15.9994	9 F Flúor 18.998403	10 Ne Neón 20.1797
3	11 Na Sodio 22.98976	12 Mg Magnesio 24.3050											13 Al Aluminio 26.98153	14 Si Silicio 28.0855	15 P Fósforo 30.97696	16 S Azufre 32.065	17 Cl Cloro 35.453	18 Ar Argón 39.948
4	19 K Potasio 39.0983	20 Ca Calcio 40.078	21 Sc Escandio 44.95591	22 Ti Titanio 47.867	23 V Vanadio 50.9415	24 Cr Cromo 51.9962	25 Mn Manganeso 54.93804	26 Fe Hierro 55.845	27 Co Cobalto 58.93319	28 Ni Níquel 58.6934	29 Cu Cobre 63.546	30 Zn Zinc 65.38	31 Ga Galio 69.723	32 Ge Germanio 72.64	33 As Arsénico 74.92160	34 Se Selenio 78.96	35 Br Bromo 79.904	36 Kr Kriptón 83.798
5	37 Rb Rubidio 85.4678	38 Sr Estroncio 87.62	39 Y Itrio 88.90585	40 Zr Zirconio 91.224	41 Nb Niobio 92.90638	42 Mo Molibdeno 95.96	43 Tc Tecnecio (98)	44 Ru Rutenio 101.07	45 Rh Rodio 102.9055	46 Pd Paladio 106.42	47 Ag Plata 107.8682	48 Cd Cadmio 112.441	49 In Indio 114.818	50 Sn Estaño 118.710	51 Sb Antimonio 121.760	52 Te Telurio 127.60	53 I Yodo 126.9044	54 Xe Xenón 131.293
6	55 Cs Cesio 132.9054	56 Ba Bario 137.327	71 Lu Lutecio 174.9668	72 Hf Hafnio 178.49	73 Ta Tantalio 180.9479	74 W Wolframio 183.84	75 Re Renio 186.207	76 Os Osmio 190.23	77 Ir Iridio 192.217	78 Pt Platino 195.084	79 Au Oro 196.9665	80 Hg Mercurio 200.59	81 Tl Talio 204.3833	82 Pb Plomo 207.2	83 Bi Bismuto 208.9804	84 Po Polonio (210)	85 At Astato (210)	86 Rn Radón (220)
7	87 Fr Francio (223)	88 Ra Radio (226)	103 Lr Laurencio (262)	104 Rf Rutherfordio (261)	105 Db Dubnio (262)	106 Sg Seaborgio (266)	107 Bh Bohrio (264)	108 Hs Hassio (277)	109 Mt Meitnerio (268)	110 Ds Darmstatio (271)	111 Rg Roentgenio (272)	112 Cn Copernicio (285)	113 Nh Nihonio (284)	114 Fl Flerovio (289)	115 Mc Moscovio (288)	116 Lv Livermorio (292)	117 Ts Teneso (294)	118 Og Oganesón (294)

57 La Lantano 138.9054	58 Ce Cerio 140.116	59 Pr Praseodimio 140.9076	60 Nd Neodimio 144.242	61 Pm Prometio (145)	62 Sm Samario 150.36	63 Eu Europio 151.964	64 Gd Gadolinio 157.25	65 Tb Terbio 158.9253	66 Dy Disprosio 162.500	67 Ho Holmio 164.9303	68 Er Erbio 167.259	69 Tm Tulio 168.9342	70 Yb Iterbio 173.054
89 Ac Actinio (227)	90 Th Torio 232.0380	91 Pa Protactinio 231.0358	92 U Uranio 238.0289	93 Np Neptunio (237)	94 Pu Plutonio (244)	95 Am Americio (243)	96 Cm Curio (247)	97 Bk Berkelio (247)	98 Cf Californio (251)	99 Es Einstenio (252)	100 Fm Fermio (257)	101 Md Mendelevio (258)	102 No Nobelio (259)

Notas

- 1 kJ/mol ≈ 96.485 eV.
- Todos los elementos tienen un estado de oxidación implícito cero.
- [illegible]
- [illegible]

Iones trapados

The Nobel Prize in Physics 2012

Serge Haroche **David J. Wineland**

Prize motivation: "for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems"

VOLUME 75, NUMBER 22 PHYSICAL REVIEW LETTERS 27 NOVEMBER 1995

Resolved-Sideband Raman Cooling of a Bound Atom to the 3D Zero-Point Energy

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P. Gould
Department of Physics, University of Connecticut, Storrs, Connecticut 06269

(Received 19 December 1994)

We report laser cooling of a single $^9\mathrm{Be}^+$ ion held in a rf (Paul) ion trap to where it occupies the quantum-mechanical ground state of motion. With the use of resolved-sideband stimulated Raman cooling, the zero point of motion is achieved 98% of the time in 1D and 92% of the time in 3D. Cooling to the zero-point energy appears to be a crucial prerequisite for future experiments such as the realization of simple quantum logic gates applicable to quantum computation.

PACS numbers: 32.80.Pj, 42.50.Vk, 42.65.Dr

Generation of Nonclassical Motional States of a Trapped Atom

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Time and Frequency Division, National Institute of Standards and Technology, Boulder, Colorado 80303-3328

(Received 11 October 1995)

We report the creation of thermal, Fock, coherent, and squeezed states of motion of a harmonically bound $^9\mathrm{Be}^+$ ion. The last three states are coherently prepared from an ion which has been initially laser cooled to the zero point of motion. The ion is trapped in the regime where the coupling between its motional and internal states, due to applied (classical) radiation, can be described by a Jaynes-Cummings-type interaction. With this coupling, the evolution of the internal atomic state provides a signature of the number state distribution of the motion.

PACS numbers: 42.50.Vk, 32.80.Pj, 32.80.Qk

Realization of the Cirac–Zoller controlled-NOT quantum gate

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Quantum computers have the potential to perform certain computational tasks more efficiently than their classical counterparts. The Cirac–Zoller proposal[1] for a scalable quantum computer is based on a string of trapped ions whose electronic states represent the quantum bits of information (or qubits). In this scheme, quantum logical gates involving any subset of ions are realized by coupling the ions through their collective quantized motion. The main experimental step towards realizing the scheme is to implement the controlled-NOT (CNOT) gate operation between two individual ions. The CNOT quantum logical gate corresponds to the XOR gate operation of classical logic that flips the state of a target bit conditioned on the state of a control bit. Here we implement a CNOT quantum gate according to the Cirac–Zoller proposal[1]. In our experiment, two $^{40}\mathrm{Ca}^+$ ions are held in a linear Paul trap and are individually addressed using focused laser beams[2]; the qubits[3] are represented by superpositions of two long-lived electronic states. Our work relies on