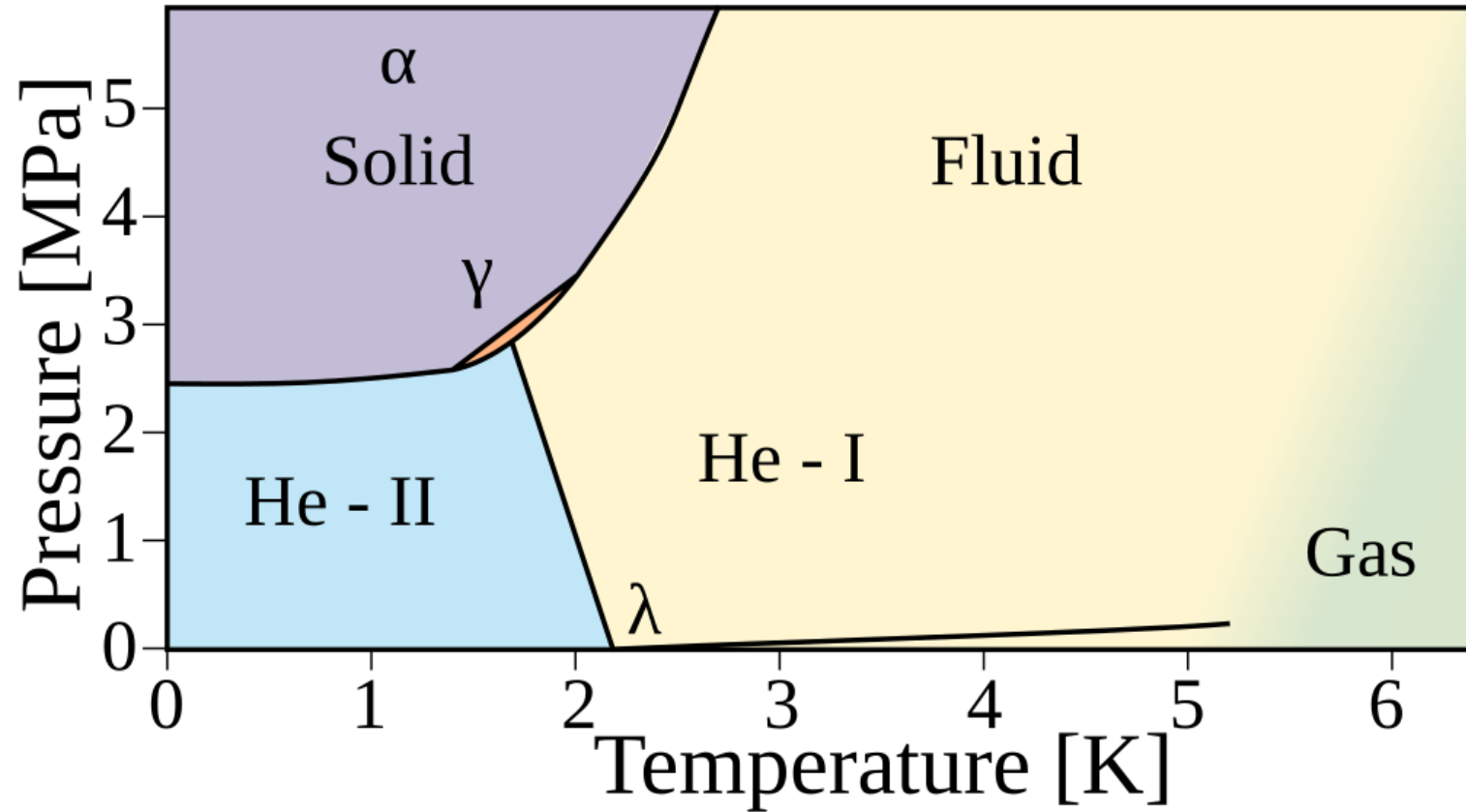


# Superfluidity

# Phase Diagram of Helium-4

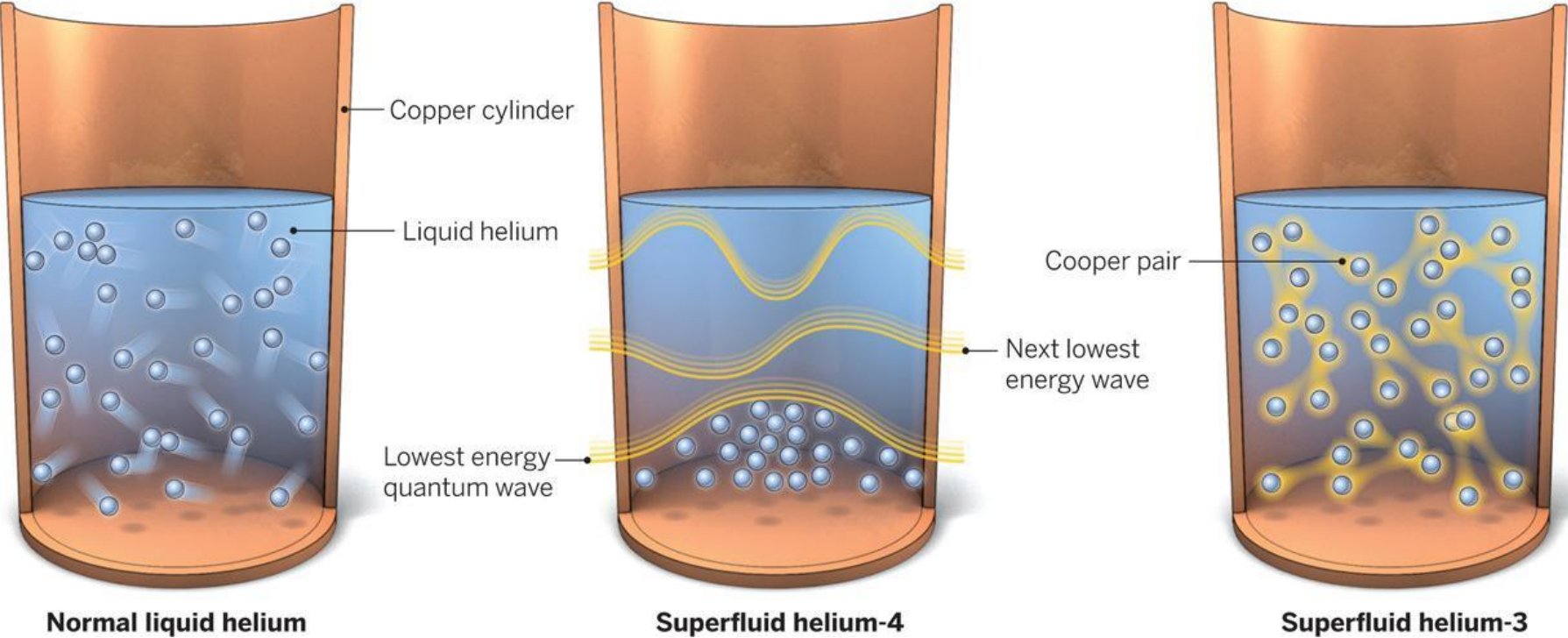


By Д.Ильин: vectorization - Phase diagram of Helium-4.png by Tretyak

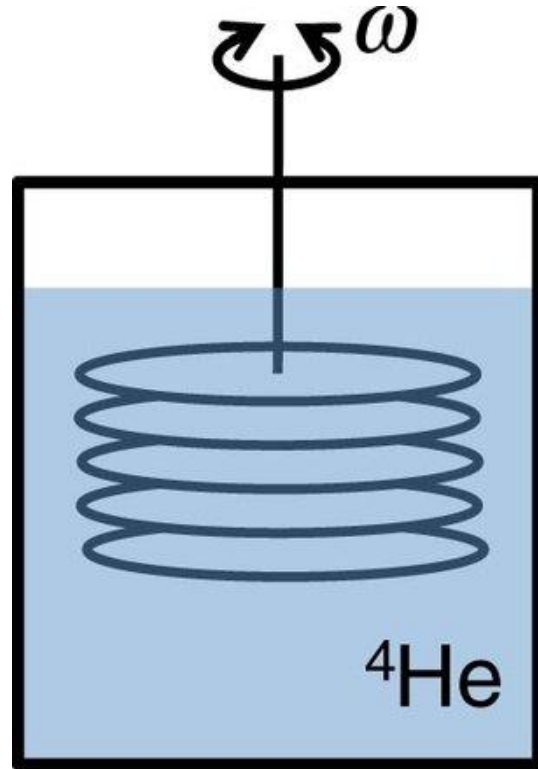
## Catch the wave

ILLUSTRATION: C. BICKEL/SCIENCE

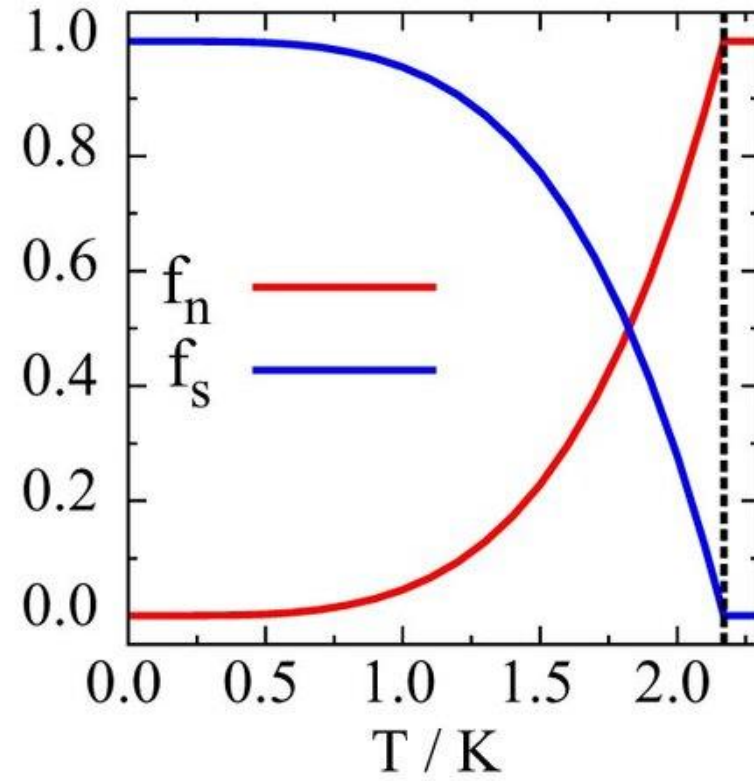
The presence of a macroscopic quantum wave gives superfluid helium bizarre properties. In a normal liquid, atoms jumble together. In superfluid helium-4, atoms crowd into the same quantum wave, and in superfluid helium-3 atoms pair and the pairs form a quantum wave.



# Andronikashvili Experiment

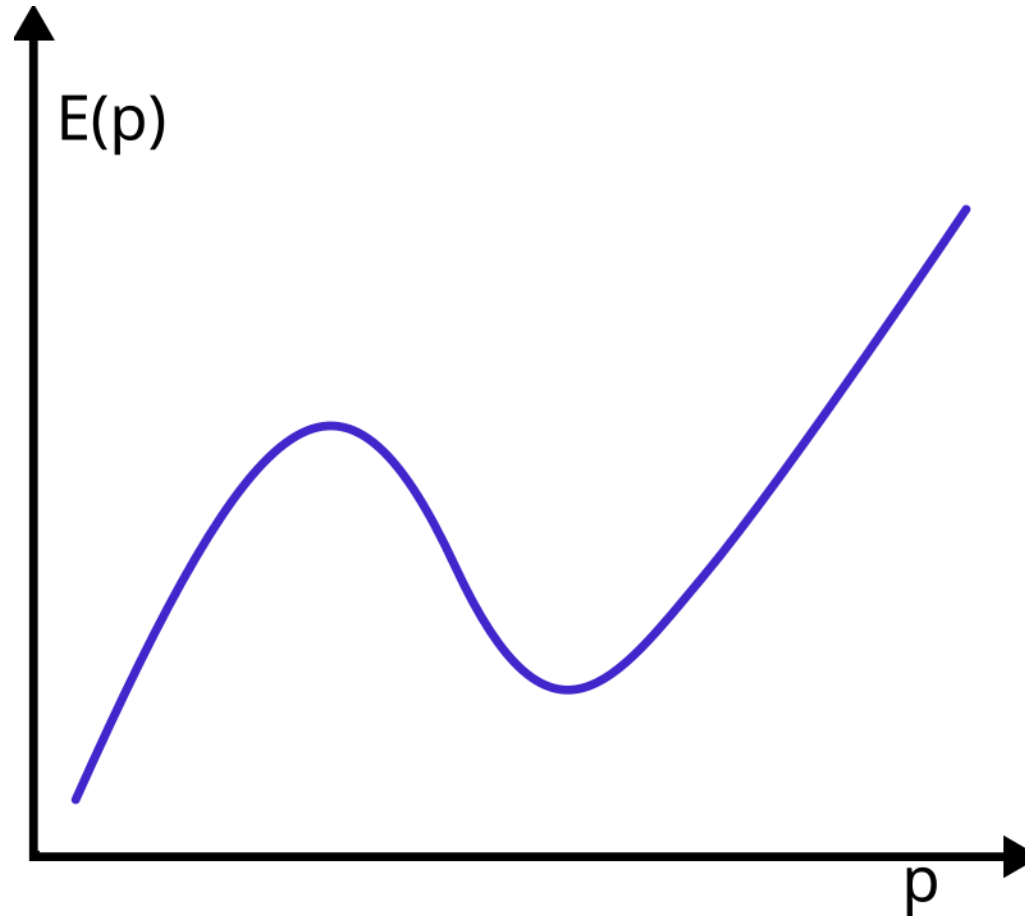


(a)



(b)

# Elementary Excitations in Liquid Helium

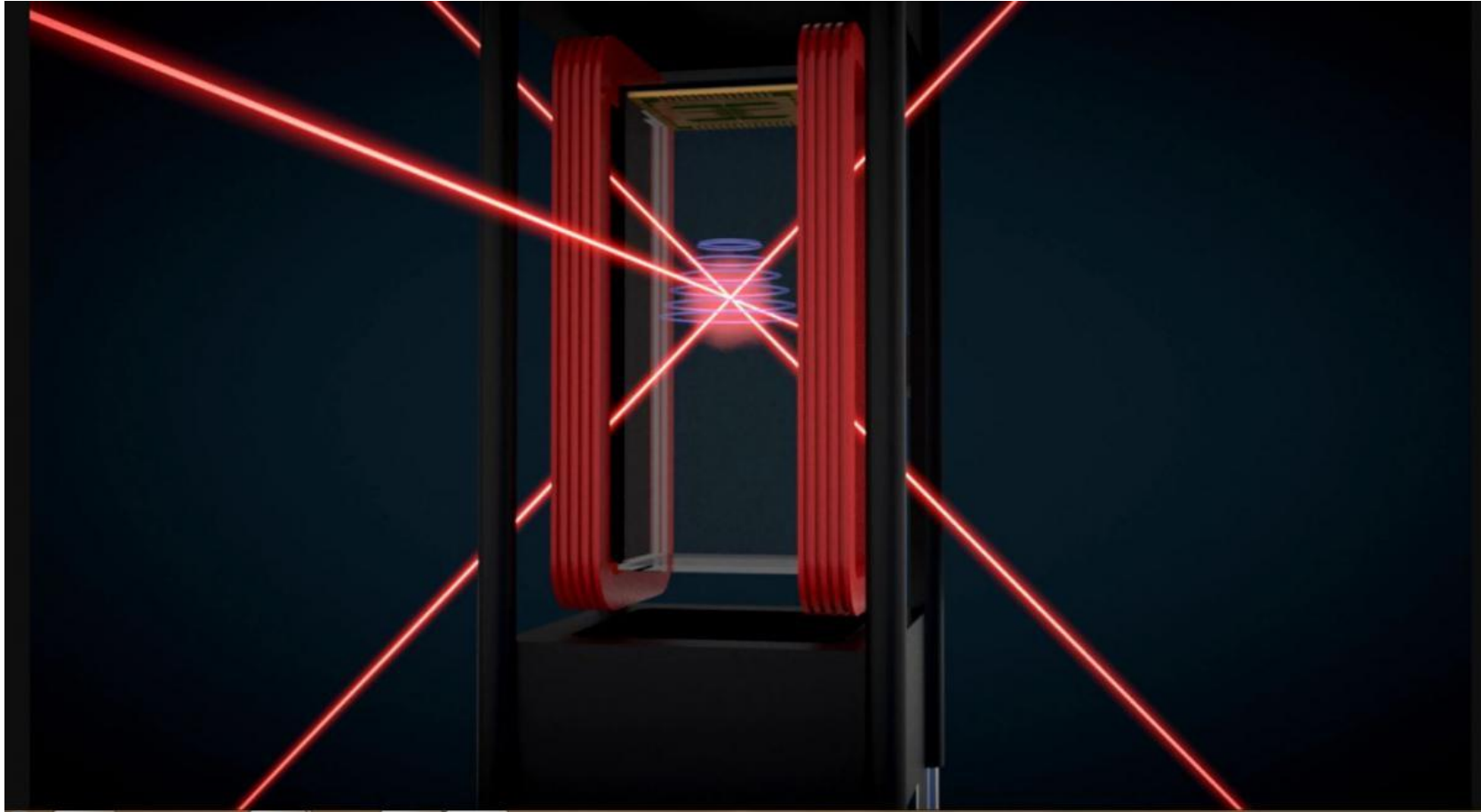


# Dilute Cold Atoms in Traps

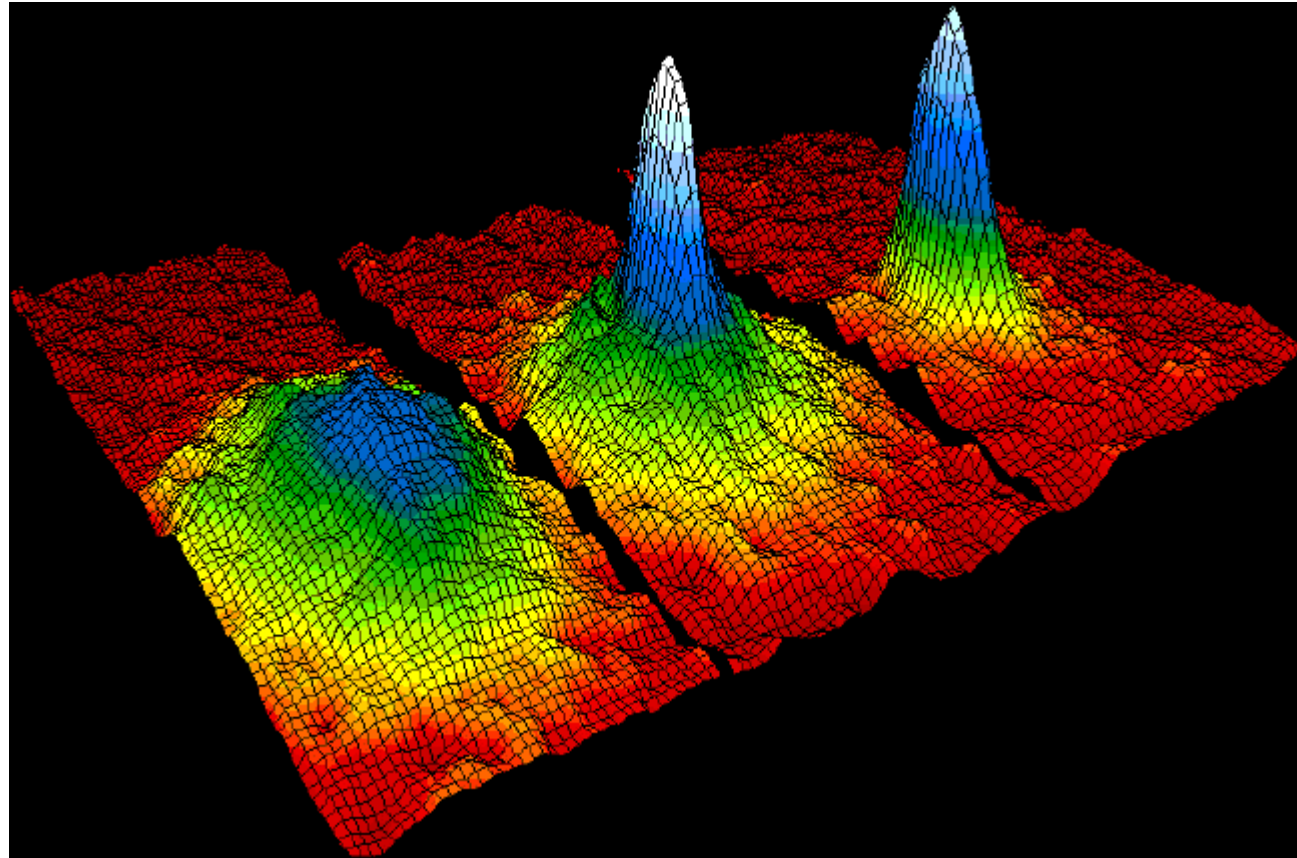
Group ▶	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18										
Period ▼																												
Nonmetals	1 H																	2 He	<i>Noble gases</i>									
Metals	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne										
	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
	19 K	20 Ca											21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
	37 Rb	38 Sr											39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
	55 Cs	56 Ba	La to Yb	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn									
	87 Fr	88 Ra	Ac to No	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og									
	s-block (plus He)		f-block	d-block									p-block (excluding He)															
Lanthanides			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb												
Actinides			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No												

Some elements near the dashed staircase are sometimes called *metalloids*

# Laser Cooling



# Emergence of the condensate



By NIST/JILA/CU-Boulder - NIST Image, Public Domain,  
<https://commons.wikimedia.org/w/index.php?curid=403804>



# Vortex Lattice in a Rotating Condensate

