

Student ranking of atomic models

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Abstract:

We have asked students to rank ten written descriptions of the atom as more or less plausible as part of a survey we have administered to beginning university physics students at the Ohio State University. The student opinions seem to fall naturally into three classes—clearly reasonable models (generally agreed to be plausible), a muddled group in no certain order, and clearly unreasonable models (generally agreed to be implausible). Our poster will discuss these student ideas.

We have administered various versions of a survey to nearly 1000 undergraduates at the Ohio State University who were taking one of the OSU physics courses. The survey is an attempt to determine student ideas about the nature of reality.

We used the concept of the *photon* as a common thread to probe students' understanding of a wide range of topics in quantum mechanics. In addition, we built most of our survey directly from quoted statements made by students during our interviews. This was done specifically in order to minimize the impact of our "expert" understanding of quantum mechanics on the students during the interviews and surveys.

As the surveys have evolved, we have interviewed individual students to make sure that they are reading the statements as we had intended. In addition, we continued to interview other groups of students about their ideas about the interaction of light and matter. At one point, we asked some of these students about their views of atoms, and received answers interesting enough to develop them further into the written survey.

We used the ranking task described on the next page to see how other students would respond to the ideas of the interviewees.

Rank the following statements about atoms from the **most plausible** to the **least plausible**. Draw a large circle around all the ones that you believe are **correct** statements.

a. An atom is made up of protons, neutrons, and electrons. The protons and neutrons make up the nucleus, which is in the center of the atom. The electrons move around outside the nucleus.

b. Atoms have a nucleus at the center, and electrons and protons that move around outside the nucleus.

c. Outside of an atom's nucleus, the electrons and protons move around in a circular ring.

d. Atoms revolve somehow around the outside of the nucleus.

e. In an atom, electrons stay in the same shell.

f. An atomic nucleus is made up of protons and neutrons.

g. Electrons in atoms orbit around the atomic nucleus.

h. Atoms are made up of a nucleus with rings that contain electrons.

i. Electrons spin around the outside of the atom in a shell.

j. An atom is set up like a solar system.

Most plausible 1. ____ 2. ____ 3. ____ 4. ____ 5. ____ 6. ____ 7. ____ 8. ____ 9. ____ 10. ____ Least plausible

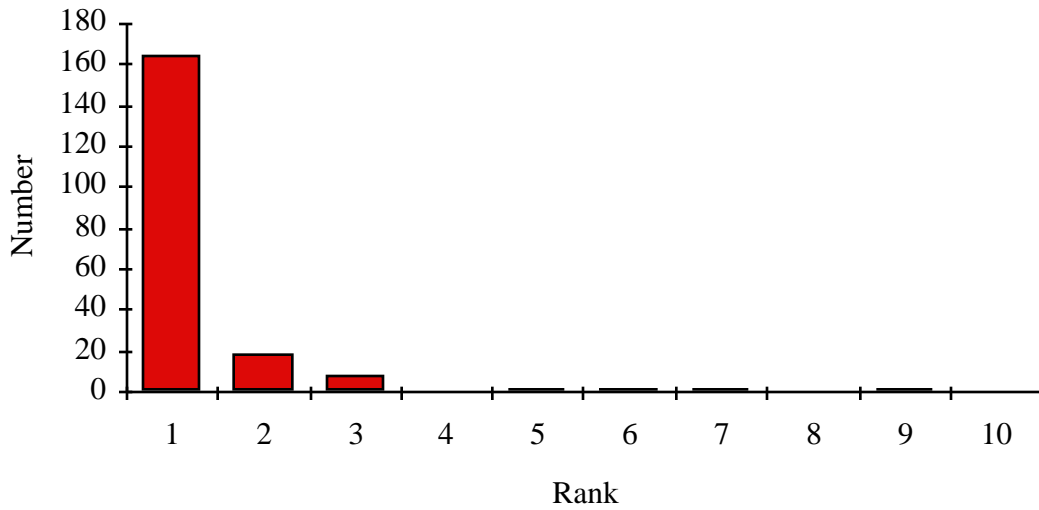
Student responses to survey question.
 (N = 228, but not all filled in every ranking)

Rank	mean	median	mode
1	a	a	a
2	f	f	f
3	g	g	g
4	i		i
5	h	i	
6	j	h, j	h, j
7	e	e	e
8	d	d	
9	c	b, c	c
10	b		b, d

Choice	mean	Choice	median	Choice	mode
a	1.35	a	1	a	1
f	2.60	f	2	f	2
g	3.73	g	3	g	3
i	4.92	i	5	i	4
h	5.54	h	6	h	6
j	5.95	j	6	j	6
e	6.72	e	7	e	7
b	7.97	d	8	c	9
d	8.02	c	9	b	10
c	8.05	b	9	d	10

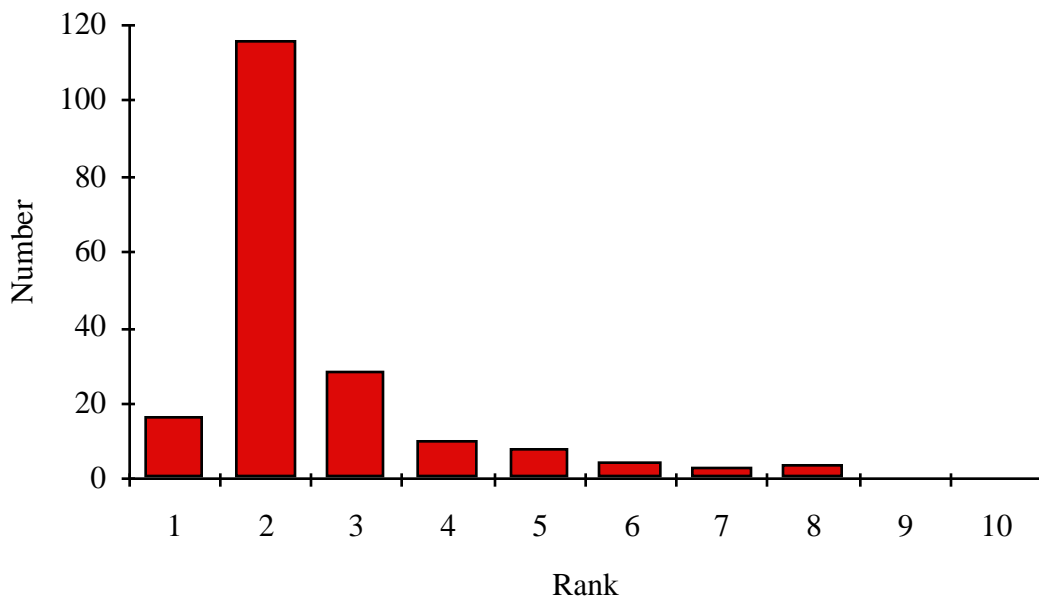
An atom is made up of protons, neutrons, and electrons. The protons and neutrons make up the nucleus, which is in the center of the atom. The electrons move around outside the nucleus.

(N = 197)



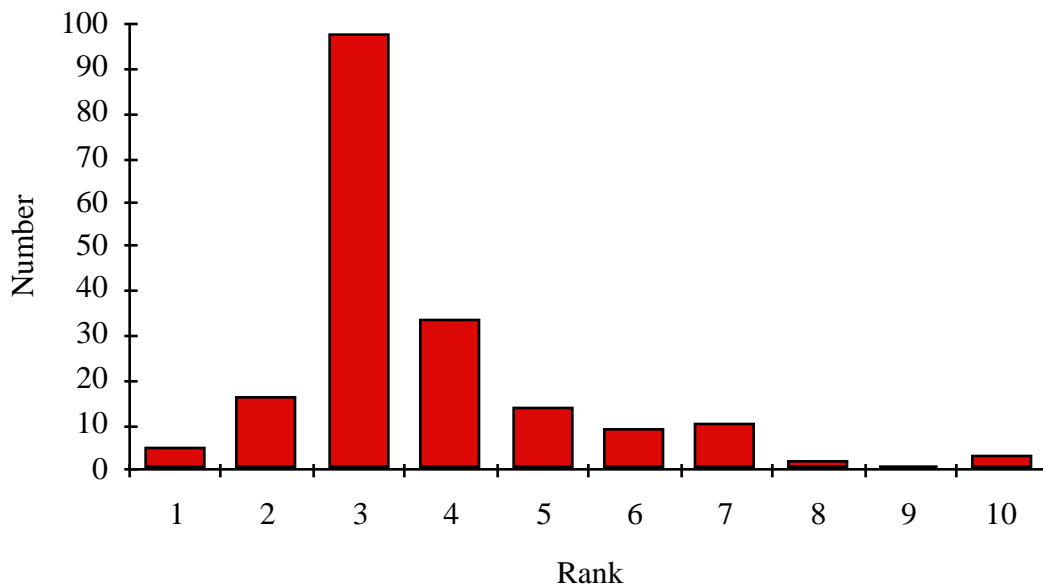
An atomic nucleus is made up of protons and neutrons.

(N = 192)



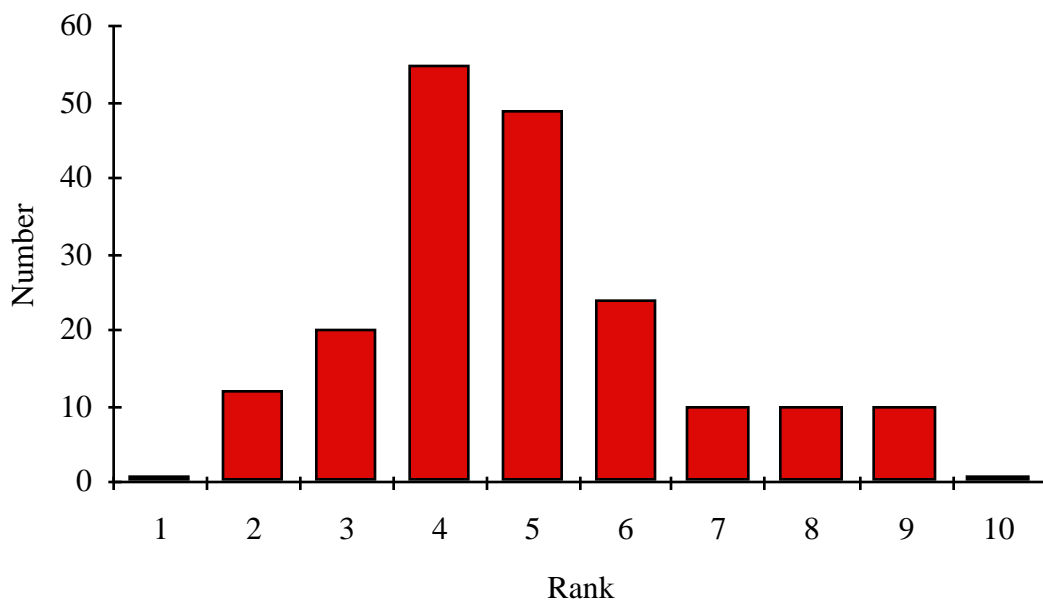
Electrons in atoms orbit around the atomic nucleus.

(N = 192)

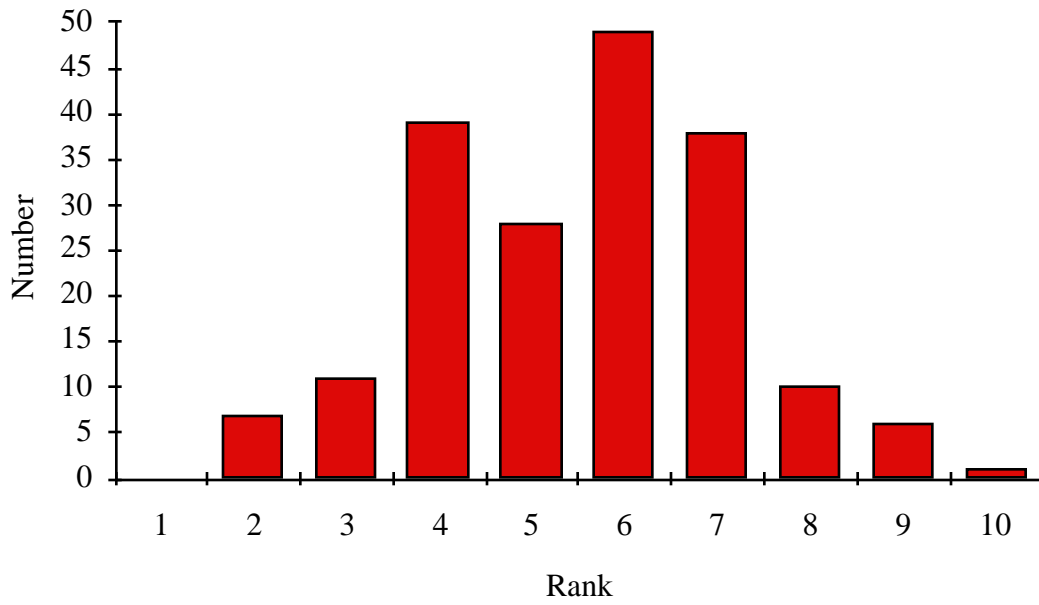


Electrons spin around the outside of the atom in a shell.

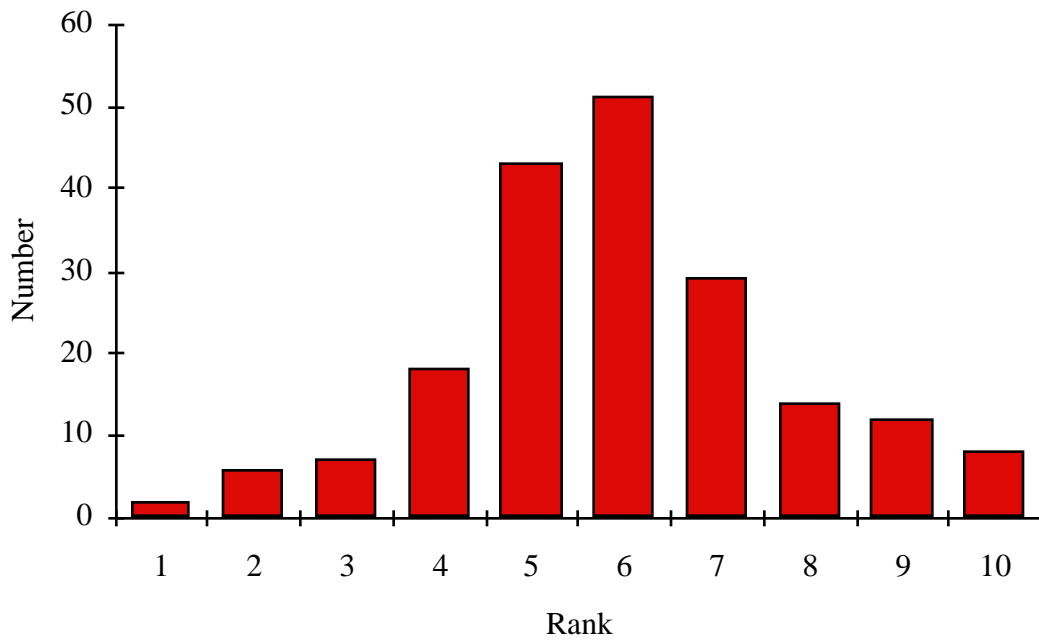
(N = 192)



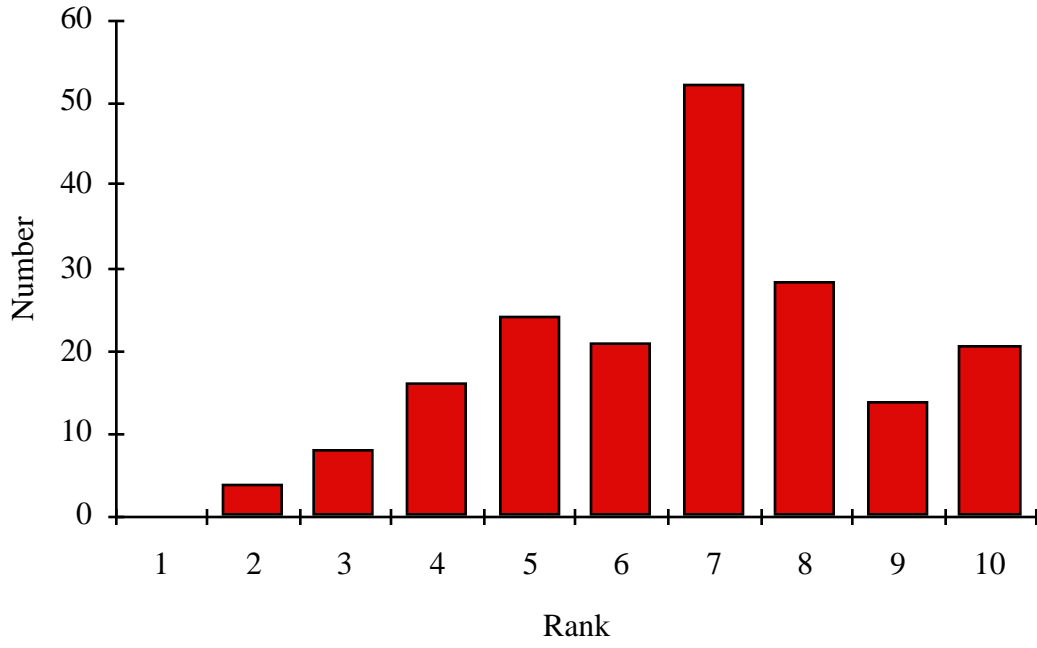
Atoms are made up of a nucleus with rings that contain electrons.
(N = 192)



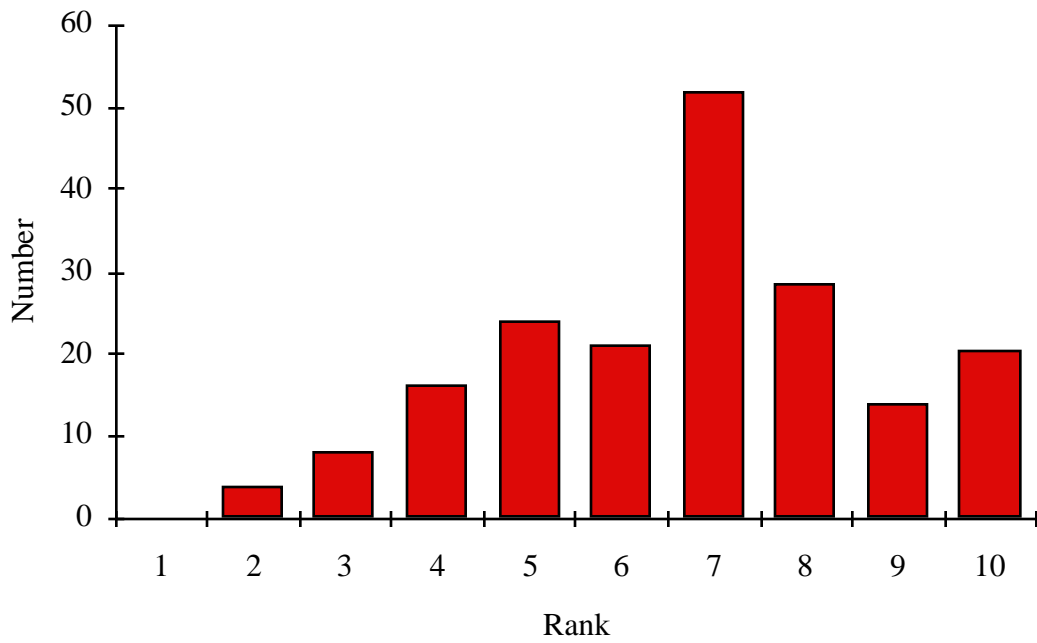
An atom is set up like a solar system. (N = 190)



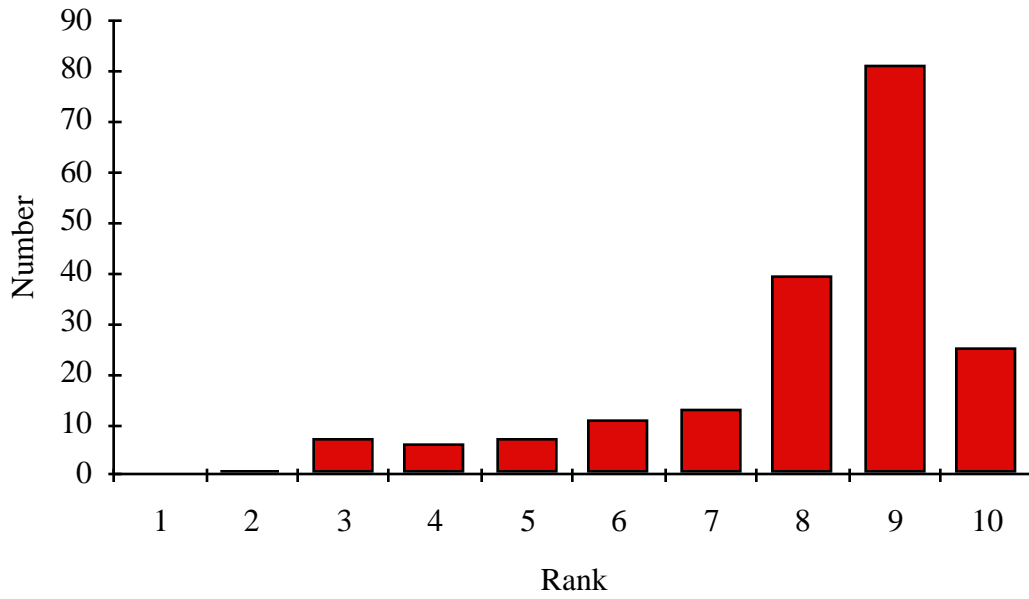
In an atom, electrons stay in the same shell. (N = 188)



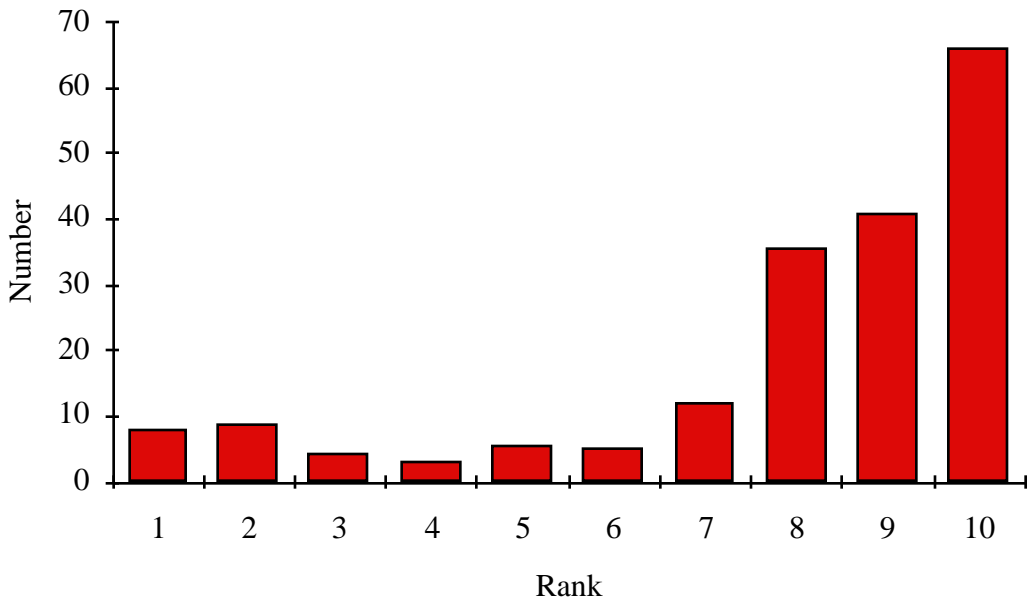
In an atom, electrons stay in the same shell. (N = 188)



Outside of an atom's nucleus, the electrons and protons move around in a circular ring. (N = 190)



Atoms have a nucleus at the center, and electrons and protons that move around outside the nucleus. (N = 190)



As may be seen from these diagrams, student opinion seems to fall into three groups.

There are clearly reasonable descriptions (generally agreed to be plausible by the students, ranked 1, 2, or 3; descriptions a, f, g).

a. An atom is made up of protons, neutrons, and electrons. The protons and neutrons make up the nucleus, which is in the center of the atom. The electrons move around outside the nucleus.

f. An atomic nucleus is made up of protons and neutrons.

g. Electrons in atoms orbit around the atomic nucleus.

There is a group that peaks toward the middle of the distribution. It would seem that these are intermediate, gathering neither overwhelming favor nor disfavor.

There is a group that seem to be perceived as unreasonable descriptions (generally agreed to be implausible by the students, ranked 7, 8, 9, or 10; descriptions e, b, d, c).

c. Outside of an atom's nucleus, the electrons and protons move around in a circular ring.

b. Atoms have a nucleus at the center, and electrons and protons that move around outside the nucleus.

d. Atoms revolve somehow around the outside of the nucleus.

e. In an atom, electrons stay in the same shell.

Students' ideas of atoms as expressed by their choices in this ranking task seem to agree reasonably well with expert views expressed in a classical language. However, small numbers of students appear to have more unconventional views of the atom.