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**The Rayotron (a High-Voltage Generator  
and X-Ray Source)\***

Name of Manufacturer: Atomic Laboratories, P. O. Box  
343, Berkeley, California.

Price List: Rayotron generator complete with beam tube:  
\$295.00  
Rayotron generator, without beam tube:  
\$175.00

Beam tube: \$140.00  
 Optional instrumentation: \$25.00  
 Fluoroscopic screen and 12 dental film plates:  
 \$20.00  
 (all prices F.O.B., Berkeley, California—im-  
 mediate delivery)

The apparatus is primarily a Van de Graaff-type generator of sturdy construction. The manufacturer claims that it will produce one-half million v with 16 in. sparks in air from its metal sphere. Tests substantiate these claims. The complete Rayotron includes a beam tube which produces high-energy x-rays. The beam tube is a cylinder of Pyrex with metal gradient rings to produce a uniform electrostatic field in which electrons are accelerated. The microammeter, selector switch, and x-ray warning signal are sold at extra cost. The sphere which is on top of the Rayotron is 11 in. in diam and rests on a 24-in. acrylite column. It rests on a base which is approximately 15 in.  $\times$  15 in.  $\times$  5 in. The base holds the meters, switches, and other controls and is made of plywood.

Without the beam tube the Rayotron is an electrostatic generator and with the beam tube it is a dangerous source of high-energy x-rays. The first impression is that with the beam tube this is indeed a very dangerous device. In the instruction manual the manufacturer warns about this danger. It says, "Extreme caution must be exerted when the Rayotron is producing x-rays. Always stand at least three or four feet away and operate only for very short periods of time. A man standing closer than one foot to the beam tube for more than five minutes in one week may be



FIG. 1. The Rayotron.

subjecting himself to overexposure." Using the beam tube, in order to turn on the machine the operator has to turn on a switch which is at the base of the generator. This implies that the operator should turn on the apparatus and move very quickly away from it. However, every time he turns it on or off, he must get very close to the source of the x-rays. A reading taken with a standard commercial Geiger counter calibrated in mr/hr, by comparison with a standard source, indicated the following readings:

Distance in meters	mr/hr
2	333
4	266
8	133

These readings were made with the slow travel of the belt. When it went fast, the readings were in excess of the maximum range of the meter. The erratic velocity of the belt at slow speeds probably accounts for the apparent departure from the inverse-square law.

While it is potentially a useful teaching tool, I think the use of the generator with the beam tube should be discouraged except by well-qualified persons. Its use in high school, in particular, should be discouraged if there is any possibility that the Rayotron generator (with the beam tube) is to be used by students without the supervision of a well-informed teacher.

Some other general impressions follow. The sphere, which is made of spun aluminum, and the plastic cylindrical support both are professional looking in appearance. The model demonstrated here had a poor finish on the woodwork which detracted considerably from the over-all good impression which the photographs created. This is perhaps a minor point since the construction in general seemed to be sturdy, but a hard plastic surface on the base which could be easily cleaned by going over with a damp cloth would add much to the appearance and utility of the base surfaces. The following questions and their answers may be of use to prospective users:

1. To what extent is this apparatus an improvement over apparatus previously available?

*Answer:* As a Van de Graaff generator, the apparatus seems better than other models, primarily in size and capacity. The 11-in. sphere seems well designed with no abrupt change in curvature at the base, but the spun aluminum is not as smooth as the nickel-plated models seen on other machines. The drive belt seems sturdier and the base larger and hence more stable than that of the other machines. However, a wooden base is neither as strong nor as professional in appearance as a metal base. The beam-tube feature can only be called an improvement if extreme caution is used. Otherwise, this feature might well be classified as a distinct disadvantage over simpler generators which have no beam tube.

2. For what level of teaching physics is it appropriate?

*Answer:* It is primarily useful in college physics teaching. However, without the beam tube it could

be used in high schools as well. I would repeat very strongly that the beam tube should not be purchased except by individuals who are well acquainted with x-ray techniques and the attendant precautions of shielding against exposure.

3. Can it be maintained reasonably well by the average physics department?

*Answer:* It seems that the construction is simple enough so that by following the instruction manual on care of the apparatus it should be possible to maintain it reasonably well without special tools or knowledge.

4. Is it overly elaborate for what it is intended to do?

*Answer:* No.

5. Are the quality of workmanship and the inherent precision of the apparatus sufficiently high?

*Answer:* It is a well-designed and well-manufactured product. The over-all appearance of the base and its possible improvement have already been mentioned.

6. How can this apparatus be improved?

*Answer:* Other than the suggestions already made, I would say that the best service which the Atomic Laboratories could give would be to delete from their advertising literature the information on the beam tube. At least it should be played down rather than played up. Where it says, "make x-ray photos and fluoroscopic images right in the classroom," as an advertising feature, it should say in the same sentence that radiological experts are urging the population not to expose themselves to any more ionizing radiation than they absolutely have to.

The advertising tends to lean to the overuse of exclamation marks, e.g., "Manual of Experiments Free with Every Order!, 30-Day Money Back Guarantee!" There is a slight exaggeration in the use of the word "encyclopedic" in the following sentence, "Order now and receive encyclopedic new syllabus on generators and their use in nuclear physics research." The syllabus is well written but it is not encyclopedic. It also says, "see Compton effect—x-ray phenomena—corona discharge." To see the Compton effect, they suggest the use of another piece of Atomic Laboratory apparatus, *viz.*, their diffusion cloud chamber. In the procedure for this experiment it says, "Set the cloud chamber in operation at about ten feet from the Rayotron. After the cloud chamber is producing satisfactory cosmic-ray tracks, turn on the Rayotron . . . and observe the formation of the electron tracks in the cloud chamber." If the cloud chamber is ten feet away from the apparatus, I can well imagine a group of half a dozen high-school students milling around it with at least one of these curious enough to get within four feet of the generator for dangerous intervals of time.

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