# Lawrence Berkeley National Laboratory

**Recent Work** 

## Title

THE FLUORESCENCE SPECTRUM OF Am+3IN LaCI3

## Permalink

https://escholarship.org/uc/item/2vk175h4

## Authors

Gruen, D.M. Conway, J.G. McLaughlin, R.D. <u>et al.</u>

Publication Date 1956-01-27

UCRL 3270

# UNIVERSITY OF CALIFORNIA



TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

BERKELEY, CALIFORNIA

### DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

### UNIVERSITY OF CALIFORNIA

F

1

Radiation Laboratory Berkeley, California

Contract No. W-7405-eng-48

# THE FLUORESCENCE SPECTRUM OF Am<sup>+3</sup> IN LaCl<sub>3</sub>

D. M. Gruen Argonne National Laboratory, Lemont, Illinois

J.G. Conway and R.D. McLaughlin University of California Radiation Laboratory

B.B. Cunningham Department of Chemistry and Radiation Laboratory University of California

January 27, 1956

Printed for the U.S. Atomic Energy Commission

## THE FLUORESCENCE SPECTRUM OF Am<sup>+3</sup> IN LaCl<sub>2</sub>

### D. M. Gruen

## Argonne National Laboratory, Lemont, Illinois

J. G. Conway and R. D. McLaughlin University of California Radiation Laboratory

B. B. Cunningham Department of Chemistry and Radiation Laboratory University of California

#### January 27, 1956

It is now well recognized that 5f electrons occur in the ground state configurations of atoms and ions of the actinide elements. l

Fluorescence is well known in a number of lanthanide ions where it occurs because of the presence of 4f electrons. By analogy, one would expect to observe fluorescence in some actinide ions.

Fluorescence has not been observed in neptunium or plutonium compounds.  $^2$  We wish to report here the first observation of the Am<sup>+3</sup> fluorescence spectrum.

Single crystals of  $LaCl_3$  (m. p.  $860^{\circ}$  C) containing 0.04 (Sample I) and 0.20 (Sample II) mol percent Am<sup>+3</sup> were grown by the Stockbarger method.

The fluorescence is self-excited at room temperature due to the radioactivity of  $Am^{2411}$ . For the observation of the fluorescence spectrum however, a 1000 w AH-6 mercury lamp was employed. The spectrum was photographed on a Jarrell-Ash 21 ft Wadsworth mount spectrograph using a 15000 lines/in grating and a 400 $\mu$  slit with exposure times of 3 to 9 hr. The dispersion of the instrument is about 5A/mm. Spectra were taken at room temperature and at liquid nitrogen temperature.

 G. T. Seaborg, Chapter 17, The Actinide Elements, National Nuclear Energy Series IV - 14A, McGraw-Hill Book Company, Inc., New York (1954).

2. G. R. Price, J. Opt. Soc. 39, 1054 (1949).

Υ.

ġ,

All of the lines observed in the fluorescence spectrum are listed in Table I together with their visually estimated intensities. Lines marked with an asterisk coincide exactly with lines found in the absorption spectrum, and may be assumed to represent transitions from excited electronic states to the  ${}^{7}F_{0}$  level of the ground state multiplet. The Am<sup>+3</sup> fluorescence spectrum shows somewhat different behavior in this respect from its analogue Eu<sup>+3</sup>. In the former, we have observed fluorescence arising from five relatively low-lying excited electronic levels whereas in the latter fluorescence is observed only from the two lowest-lying electronic levels above the  ${}^{7}F$  ground state multiplet. 3.

-3-

The  $Am^{+3}$  fluorescence spectrum is different in still another way. The two lines at 4565A and 5227A are observed only at room temperature where they are very strong. They disappear completely at 77° K.

Most of the lines listed except the most intense ones are observed only at  $77^{\circ}$  K.

An attempt has been made to rule out as far as possible effects due to lanthanide or actinide impurities. The LaCl<sub>3</sub> starting material for Sample I came from the Lindsay Light and Chemical Co. Absorption spectra taken at 77° K on a single crystal of this material 1 cm thick revealed the presence of a  $Pr^{+3}$  impurity of  $\approx 0.01$  mol percent. The LaCl<sub>3</sub> starting material for Sample II came from Research Chemicals Co. Low temperature absorption spectra on a single crystal of this material showed no absorption lines due to other rare earths. The americium, (475-year alpha emitting Am<sup>241</sup>, originating from  $\beta^-$  decay of  $Pu^{241}$ ) was given a final purification by ion exchange from concentrated HCl solution using a Dowex-50 column. Sample I was given a single, and Sample II a double, column purification. No lanthanide or actinide impurities were found in either of these samples by emission spectroscopic analysis.

The fluorescence spectra obtained from Samples I and II were identical in every respect except that Sample I had two extra lines which could be identified as  $Pr^{+3}$  fluorescence lines since they correspond exactly with two of the  $Pr^{+3}$  absorption lines found in the LaCl<sub>3</sub> starting material.

3. E. V. Sayre, and S. Freed, J. Chem. Phys., (in press).

We are in the process of studying the polarization properties of the fluorescence lines as an aid to an interpretation of the spectrum.

A search is being made for the fluorescence of  $Pu^{+\beta}$ .

We wish to acknowledge the skillful purification of americium by Dr. J. C. Wallmann. We thank the Health Chemistry Group for the design and construction of radiation protection equipment. One of us (D. M. G.) wishes to thank Dr. W. M. Manning of the Argonne National Laboratory and Dr. G. T. Seaborg of the Radiation Laboratory for making it possible for him to spend a year at the Radiation Laboratory.

This work was performed under the auspices of the Atomic Energy Commission at the University of California Radiation Laboratory.

| No.         | Wavelength (A) | Intensity | No. | Wavelength   | Intensity |
|-------------|----------------|-----------|-----|--------------|-----------|
| ī. <b>F</b> | 4249 *         | 2         | 18  | 4789         | 1         |
| 2           | 4311 *         | 2         | 19  | 4806         | 1         |
| 3           | 4565 <b>*</b>  | 9         | 20  | 4809         | 1         |
| . 4         | 4626 ×         | 10        | 21  | 5220         | 1         |
| 5           | 4641           | 1         | 22  | 5227         | 3         |
| 6           | 4654           | 5         | 23  | 5251         | 1         |
| 7           | 4667           | 1         | 24  | 5259         | 1         |
| 8           | 4669           | 1         | 25  | 5284         | 5         |
| 9           | 4672           | 2         | 26  | 5292         | 1         |
| 10          | 4687           | 1         | 27  | 5309         | 3         |
| 11          | 4694           | 1         | 28  | 5320         | 3         |
| 12          | 4718           | 6         | 29  | 532 <b>6</b> | . 1       |
| 13          | 4722           | 1         | 30  | 5952         | 2         |
| 14          | 4732           | 1         | 31  | 5969         | 2         |
| 15          | 4754           | 8         | 32  | 6119         | 9         |
| 16          | 4772           | 7         | 33  | 6155         | 8         |
| 17          | 4782           | 1         | 34  | 6714         | 3         |

# TABLE I FLUORESCENCE SPECTRUM OF $Am^{+3}$ IN LaCl<sub>3</sub>