

# New Insights into the Influence of the $4f^55d^1$ State in the $4f^6$ Electronic Configuration of $\text{Sm}^{2+}$ in Crystal Hosts

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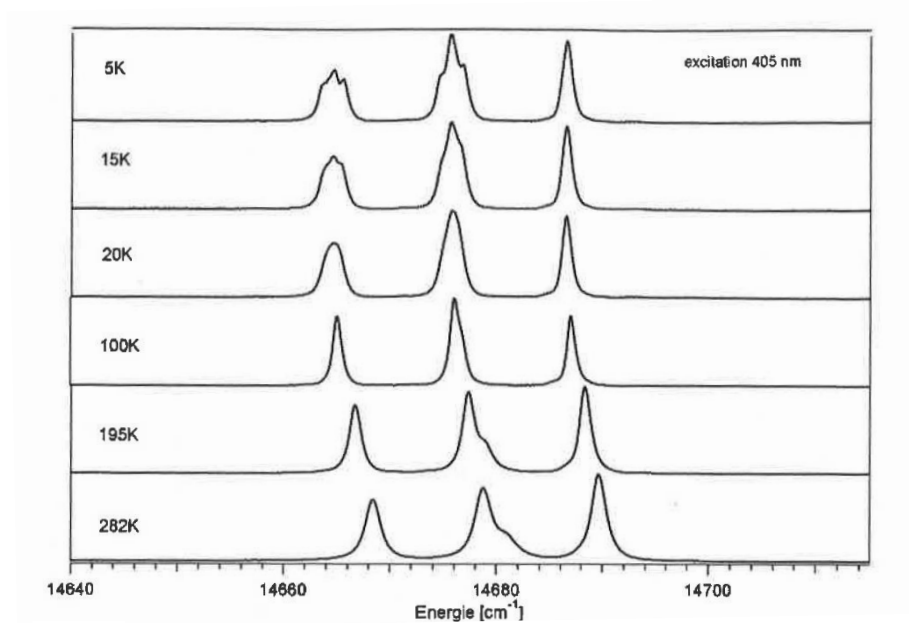
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## Supporting Information

### Effect of the temperature on the $^5\text{D}_0 - ^7\text{F}_0$ peak position in $\text{SrAlF}_5:\text{Sm}^{2+}$

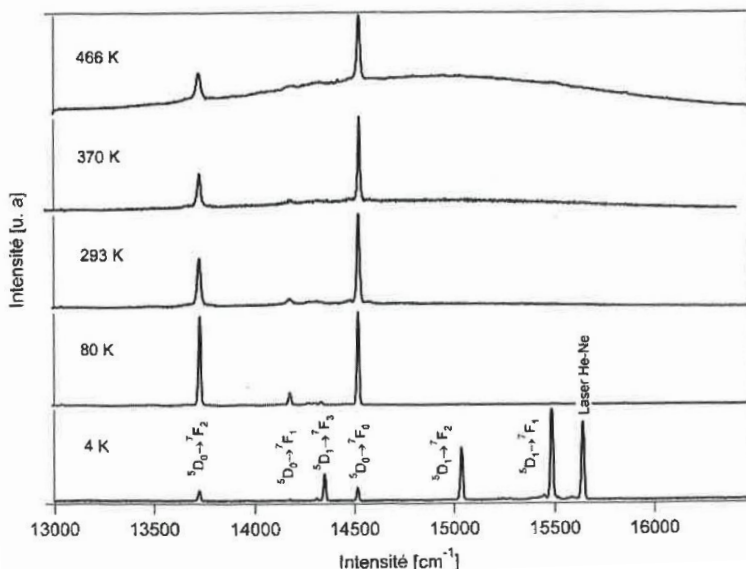
As can be seen on Figure S1, the four  $^5\text{D}_0 - ^7\text{F}_0$  peaks of  $\text{Sm}^{2+}$  in  $\text{SrAlF}_5$  are displaced by less than  $5 \text{ cm}^{-1}$  from 282 to 5 K. A temperature issue within the data reported in the paper is then not expected.



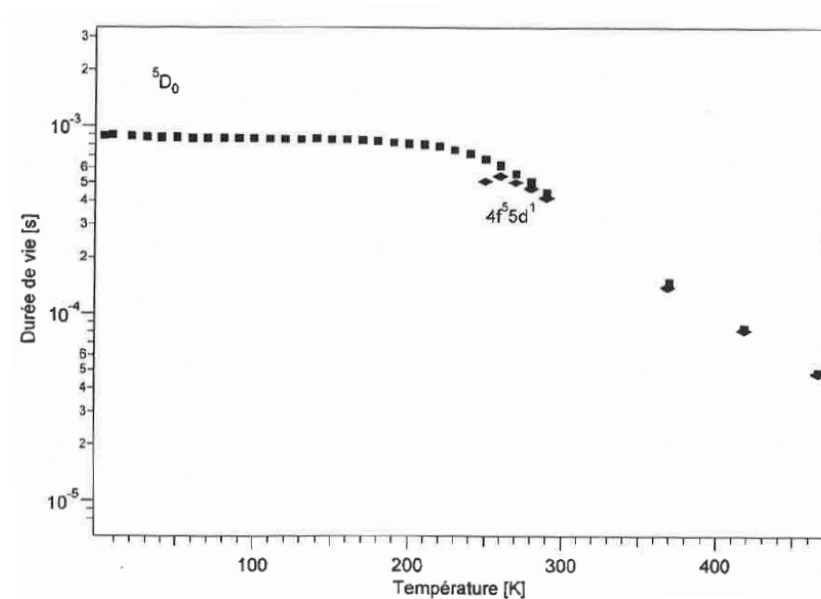
**Figure S1:** Variation of the  $^5\text{D}_0 - ^7\text{F}_0$  peak position of  $\text{SrAlF}_5:\text{Sm}^{2+}$  between 5 and 282 K (reproduced from [S1]).

## Superposition of the $4f^6$ and $4f^55d^1$ emissions and lifetime correlation in $\text{BaFl:Sm}^{2+}$

The  $4f^6$  and  $4f^55d^1$  emissions from  $\text{Sm}^{2+}$  in BaFl are superimposed, evidencing an interaction between these two configurations (Figure S2). Moreover, a study of the  $^5D_0$  and  $4f^55d^1$  lifetimes points out a strong correlation between these two levels (Figure S3).

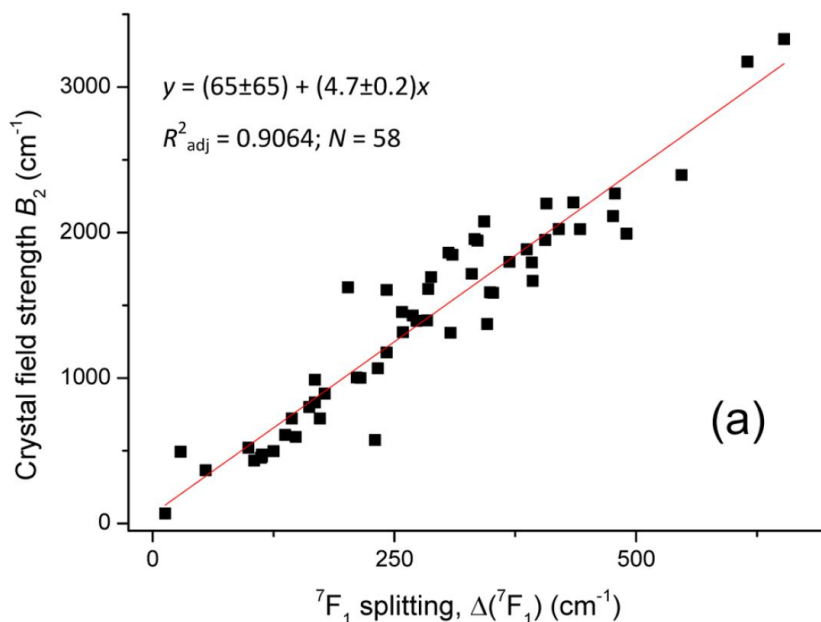


**Figure S2:** Emission spectra of  $\text{BaFl:Sm}^{2+}$  recorded at various temperatures (reproduced from [S1]).

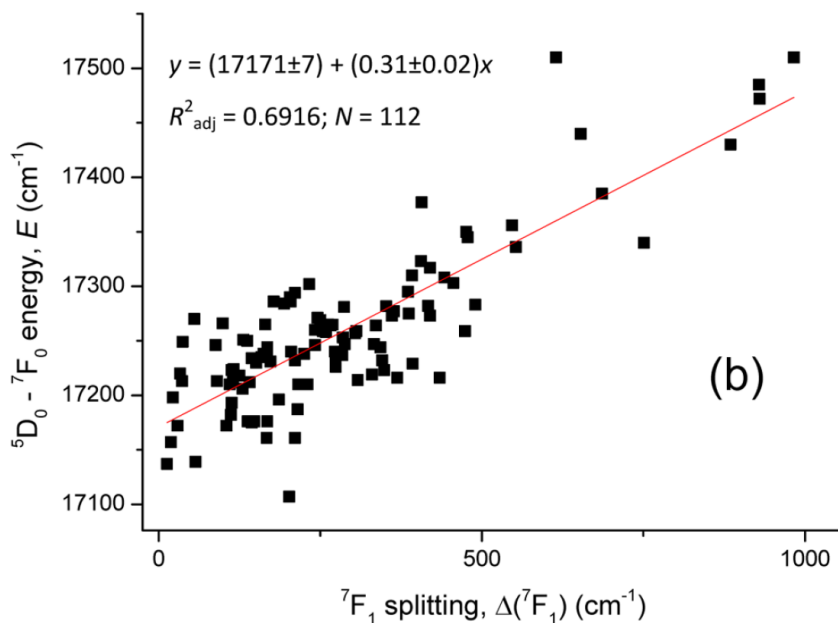


**Figure S3:**  $^5D_0$  and  $4f^55d^1$  lifetimes in  $\text{BaFl:Sm}^{2+}$  determined at various temperatures (reproduced from [S1]).

## Effect of the crystal field on the ${}^7F_1$ splitting and the ${}^5D_0 - {}^7F_0$ energy for $\text{Eu}^{3+}$ -doped crystals



**Figure S4:** Axial scalar crystal field strength parameter  $Nv^2$  (here called  $B_2$ ) as a function of  $\Delta({}^7F_1)$  for  $\text{Eu}^{3+}$ -doped crystals (reproduced from [S2]).



**Figure S5:**  ${}^5D_0 - {}^7F_0$  energy  $E$  as a function of the  ${}^7F_1$  state splitting  $\Delta({}^7F_1)$  for  $\text{Eu}^{3+}$ -doped crystals (reproduced from [S2]).

## Data of the $^5D_1$ state splitting in various $Sm^{2+}$ -containing hosts

The  $^5D_1$  states splitting ( $\Delta^5D_1$ ) was calculated as the difference between the highest and lowest energy levels, without any consideration for their symmetry.

**Table S1:**  $\Delta^5D_1$  of  $Sm^{2+}$ -doped hosts from the literature.

Host	$\Delta^5D_1$ (cm <sup>-1</sup> )	Reference	Host	$\Delta^5D_1$ (cm <sup>-1</sup> )	Reference
CaFCl	11.3	S3	BaFCl	27.0	S1
SrFCl	6.9	S4	BaCl <sub>2</sub>	16.7	S7
BaFCl	8.0	S5	BaBr <sub>2</sub>	12.6	S7
SrFBr	14.6	S6	BaMgF <sub>4</sub>	32.0	S1
BaFBr	9.7	S6	SrB <sub>4</sub> O <sub>7</sub>	32.4	S8

## References

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