for values of $x \geq 1.80$. In a recent attempt to make the garne with $x = 1.95$, the specimen obtained was clearly not single phas and the garnet phase present had $a = 12.517$ Å, 0.004 Å highe than our previous value. ESPINOSA's work[63], indicated that the $Nd_2O_3$ we had used must have contained an impurity ion smaller than $Nd^{3+}$. He obtained a value of 12.488 as opposed to 12.485 Å for the $x = 1.5$ specimen. The new maximum $a$ value is in line with this differenc and still indicates maximum $x = 1.88$.

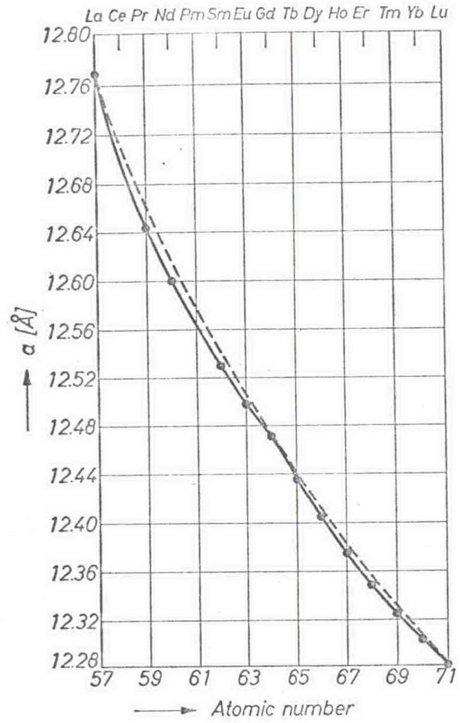

Fig. 4. Lattice constant vs atomic number for rare-earth iron garnets. Dashe curve passes through values for the trivalent rare earths with spherical electroni configuration (after ESPINOSA[63])

ESPINOSA also determined maximum $x$ for $M \equiv Pr$ and La in th systems $\{Y_{3-x}M_x\}Fe_2Fe_3O_{12}$ to be 1.33 and 0.45, respectively. He als determined the maximum substitution of Pr for Lu, Gd and Sm i their iron garnets. The results are shown in Fig. 3 taken from ESPINOSA's paper. It is seen that a maximum lattice constant for an iron garnet, obtained by extrapolation is 12.538 Å in good agreemen with 12.540 Å obtained by GELLER *et al.*[64] who first determined thi

value from their work with Nd substituted iron garnets. This value is just about 0.02 Å too small to allow the existence of $Pm_3Fe_2Fe_3O_{12}$. It is just about realized by the garnet $\{Pr_{0.25}Sm_{2.75}\}Fe_2Fe_3O_{12}$[63].

A plot of $a$ vs atomic number taken from ESPINOSA's paper is given in Fig. 4. It shows the small crystal-field effects on the rare-earth ions not having spherical electronic configurations and the expected cusp at the $Gd^{3+}$ ion.

BERTAUT and FORRAT[62] predicted a value of 12.57 Å for a PmFe garnet, we obtained[64] 12.561 Å. The latter value is also obtained from the curve in ESPINOSA's paper. For a hypothetical $\{Ce_3\}Fe_2Fe_3O_{12}$, a value of 12.699 Å would be obtained from the same curve.

In the case of the gallium garnets, while there have been numerous investigations involving Tb and Tm garnets, I have not been able to find a report of the lattice constants of these with ideal stoichiometry. The lattice constants of the others have been mainly determined first by BERTAUT and FORRAT[58] and then by SCHNEIDER *et al.*[57] and by SWANSON *et al.*[67,68] on the materials made by SCHNEIDER *et al.* Because those of SWANSON *et al.* are insignificantly different from those of SCHNEIDER *et al.*, only the averages of the two (which in no case differ by more than 0.002 Å) are listed. For YGa garnet, there are several values, the best seeming to be 12.274 ± 0.001 Å.

In the early work on a few of the gallium and aluminum garnets done by KEITH and ROY[56], it was found that excess yttrium or rare-earth oxide was soluble in the garnet. No proof was given, but it was postulated that the large ions were replacing the $Ga^{3+}$ or $Al^{3+}$ ions in octahedral sites. Some of the gallium-garnet crystals grown by REMEIKA (see Ref. [4]) showed solid-solution ranges within the same batch. Subsequently, SCHNEIDER *et al.*[57] explored these solid solutions in the rare earth and yttrium gallium garnet systems. They found that the "solubility" and lattice constant increase with decreasing rare earth ion radius until $Tm^{3+}$ is reached, then both decrease. For $Y^{3+}$, both the range of solid solution and lattice-constant difference were substantially larger than those for $Ho^{3+}$ with the same size.

SCHNEIDER *et al.*[57] also believe that in these solid solutions, the $Ga^{3+}$ ions in $a$ sites are replaced by the excess rare-earth ions. They mention that I said, in private communication, that the solid solution may be of the "interstitial and/or vacancy types instead of substitutional and thus results in a defect structure". I cannot remember exactly what I said but surely there are no interstitial sites in the garnet structure to be occupied. However, I did think it probable