## Integrality Properties

|  | 1 | $k_{2}$ | $\cdots$ | $k_{r}$ |
| :---: | :---: | :---: | :--- | :---: |
| $G$ | 1 | $g_{2}$ | $\cdots$ | $g_{r}$ |
| $\chi_{1}$ | 1 | 1 | $\cdots$ | 1 |
| $\chi_{2}$ | $d_{2}$ | $\chi_{2}\left(g_{2}\right)$ | $\cdots$ | $\chi_{2}\left(g_{r}\right)$ |
| $\vdots$ | $\vdots$ | $\vdots$ | $\ddots$ | $\vdots$ |
| $\chi_{r}$ | $d_{r}$ | $\chi_{r}\left(g_{2}\right)$ | $\cdots$ | $\chi_{r}\left(g_{r}\right)$ |

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Claim. The $\lambda_{i}$ 's are algebraic integers.
(They are e-values of $\left[\kappa_{j}\right]$.)
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Corollary. If $\operatorname{gcd}\left(k_{j}, \chi_{i}(1)\right)=1$, then $\chi_{i}\left(g_{j}\right) / \chi_{i}(1)$ is an algebraic integer.

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If $\mathbb{C}[G] \cong n_{1} S_{1} \oplus \cdots \oplus n_{r} S_{r}$, then the left-multiplication action of $\kappa_{j}$ on $S_{i}$ has matrix $\lambda_{i} I_{n_{i}}$ and also $\sum_{g \in K_{G}(g)}\left[\rho_{i}(g)\right]$.
Equating traces yields $\lambda_{i} \cdot \chi_{i}(1)=k_{j} \cdot \chi_{i}\left(g_{j}\right)$, or $\lambda_{i}=k_{j} \cdot \chi_{i}\left(g_{j}\right) / \chi_{i}(1)$.
Summary. $k_{j} \cdot \chi_{i}\left(g_{j}\right) / \chi_{i}(1)$ is an algebraic integer for any $i, j$.
Corollary. If $\operatorname{gcd}\left(k_{j}, \chi_{i}(1)\right)=d$, then $\left(\frac{d}{\chi_{i}(1)}\right) \chi_{i}\left(g_{j}\right)$ is an algebraic integer.
Proof. Choose $m, n \in \mathbb{Z}$ such that $m k_{j}+n \chi_{i}(1)=d$. Multiply by $\chi_{i}\left(g_{j}\right) / \chi_{i}(1)$ :

$$
m\left(k_{j} \cdot \chi_{i}\left(g_{j}\right) / \chi_{i}(1)\right)+n \chi_{i}\left(g_{j}\right)=\left(\frac{d}{\chi_{i}(1)}\right) \chi_{i}\left(g_{j}\right) . \square
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Corollary. If $\operatorname{gcd}\left(k_{j}, \chi_{i}(1)\right)=1$, then $\chi_{i}\left(g_{j}\right) / \chi_{i}(1)$ is an algebraic integer.

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