

idempotent, this condition is equivalent to $\phi(d(I + afM))(I + afM) = \phi(d(I + afM))$ for all $d \in D$. That is,

$$(*) \phi(dI)I + a[\phi(dI)fM + \phi(dfM)I] + a^2\phi(dfM)fM = \phi(dI) + a\phi(fM).$$

If (*) holds for three values of a , then (c) is satisfied; and (c) clearly implies (*) for all choices of $a \in \hat{Q}_p$.

LEMMA 5. *If $\phi \in \text{End}_Q(D)$ and $f \in \hat{F}$ are such that $N_\phi(1) = N_\phi(f) = \hat{Q}_p$, then $\phi f = f\phi$ (considering f as the left translation $\lambda(f)$).*

Proof. Let $d \in D$ be arbitrary. By Lemma 4, $N_\phi(1) = \hat{Q}_p$ yields $\phi(dfI)M + \phi(dfM)I = \phi(dfM)$, and $N_\phi(f) = \hat{Q}_p$ implies $\phi(dI)fM + \phi(dfM)I = \phi(dfM)$. Thus, $[\phi(dfI) - f\phi(dI)]IM = [\phi(dfI) - \phi(dI)f]M = 0$, since f centralizes \hat{D} . Consequently, $[\phi(dfI) - f\phi(dI)]I = 0$ because the rows of γ are linearly independent over $K \otimes_F D$. By Lemma 4(c)(i), $(\phi f - f\phi)dI = 0$. Since $d \in D$ is arbitrary, $(\phi f - f\phi)\hat{D}I = 0$; and $\phi f = f\phi$ by Lemma 3.

PROPOSITION. *There exists $\alpha \in \hat{F}$, transcendental over K' , such that $QE(G(\alpha)) = D$.*

Proof. To simplify notation, write Φ for $\text{End}_Q(D) \setminus \text{End}_F(D)$. Choose $f \in F$ so that $F = Q(f)$. If $\phi \in \text{End}_Q(D)$ satisfies $\phi f = f\phi$, then $\phi \in \text{End}_F(D)$. Hence, by Lemmas 4 and 5, $\phi \in \Phi$ implies $|N_\phi(1)| \leq 2$ or $|N_\phi(f)| \leq 2$. Assume that $b \in \hat{Q}_p$ is such that $|N_\phi(b + f)| \leq 3$. By Lemma 4,

$$\phi(dI)I = \phi(dI), \quad \phi(dM)M = 0,$$

and

$$b(\phi(dI)M + \phi(dM)I - \phi(dM)) + (\phi(dI)fM + \phi(dfM)I - \phi(dfM)) = 0$$

for all $d \in D$. If also $b \neq c \in \hat{Q}_p$ and $|N_\phi(c + f)| \leq 3$, then $\phi \in \text{End}_F(D)$ by Lemmas 4 and 5. Hence, if $\phi \in \Phi$ and $|N_\phi(b + f)| \geq 3$, then $|N_\phi(c + f)| \leq 2$ for all $c \neq b$ in \hat{Q}_p . Since $\text{End}_\phi(D)$ is countable and \hat{Q}_p is uncountable, there exists $c \in \hat{Q}_p$ such that $|N_\phi(c + f)| \leq 2$ for all $\phi \in \Phi$. The countability of K' then implies the existence of $a \in \hat{Q}_p$, transcendental over $K'(c)$, such that $a \notin N_\phi(c + f)$ for all $\phi \in \Phi$. By the definition of $N_\phi(c + f)$, this means that $\Phi \cap QE(G(a(c + f))) = \emptyset$. Hence, $QE(G(\alpha)) \subseteq \text{End}_F(D)$, where $\alpha = a(c + f)$ is transcendental over K' . By Lemma 2, $QE(G(\alpha)) = D$.

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