A characterization of the Kostrikin radical of a Lie algebra.

International Workshop: ”Infinite-Dimensional Lie Algebras”

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(joint work with E. García)

History

Theorem

Let R associative. Then

- *semiprime and d.c.c. on left ideals.*
- $R \cong \bigoplus_{i=1}^{k} \mathcal{M}_{n_1}(\Delta_{n_i})$

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- d.c.c. on left ideals,

$$I_1 \subset I_2 \subset \cdots \subset I_n \subset \cdots$$

$\exists m \mid I_m = I_{m+s}$ for all $s \in \mathbb{N}$

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  - I inner: if $IRI \subset I$.

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Theorem

Let L be a simple Lie algebra over a field F of characteristic 0 or greater than 7. Then L is Artinian and nondegenerate if and only if it is one of the following:

1. *A division Lie algebra.*
2. *A (finite dimensional over its centroid) simple exceptional Lie algebra.*
3. $[R, R]/[R, R] \cap Z(R)$, *where R is a simple Artinian associative algebra.*
4. $[K, K]/[K, K] \cap Z(R)$, *where* $K = \mathrm{Skew}(R, *)$ *and R is a simple associative algebra with involution* $*$ *which coincides with its socle, such that...*

History

Theorem

Let L nondegenerate. $Soc(L) := \sum I_\alpha$, I_α *minimal inner ideal of* L

- $Soc(L) = \oplus M_i$ *with* M_i *simple nondegenerate coinciding with its socle.*

History

Theorem

L Lie simple, nondegenerate, char $= 0$ or > 7 with I minimal, then:

1. *A (finite dimensional over its centroid) simple exceptional Lie algebra with Jordan elements.*
2. $L \cong [R, R]/Z(R) \cap [R, R]$, *R simple associative with socle not a division algebra.*
3. $L \cong [K, K]/Z(R) \cap [K, K]$ *for* $K = \mathrm{Skew}(R, *)$, *R simple associative algebra with isotropic involution* $*$, *with socle and where either* $Z(R) = 0$ *or the dimension of R over* $Z(R)$ *is greater than* 16.

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$$\boxed{\exists \{I_\alpha\}_{\alpha\in\Delta} \text{ ideals of } L \text{ such that } L/I_\alpha \text{ is s.p and } \bigcap_{\alpha\in\Delta} I_\alpha = 0}$$

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- Prime, $I, J \lhd R$, $IJ = 0 \implies I = 0$ or $J = 0$

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Kostrikin radical

- $x \in L$ **absolute zero divisor**, $[x, [x, L]] = 0$.
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- $K(L) = \bigcup_\alpha K_\alpha(L)$ donde $K_\alpha(L)$: (Kostrikin radical)
  - $K_1(L) \triangleleft L$ ideal generate by A.Z.D L.
  - $K_\alpha(L) = \bigcup_{\beta<\alpha} K_\beta(L)$ with α ordinal limit, and
  - $K_\alpha(L)/K_{\alpha-1}(L) = K_1(L/K_{\alpha-1}(L))$ other case.

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  - $K_\alpha(L)/K_{\alpha-1}(L) = K_1(L/K_{\alpha-1}(L))$ other case.
- $I \triangleleft L$ non degenerate (s.p.) if L/I is non-degenerate (s.p.).

1. L non-degenerate $\iff$ L is a S.P of strongly prime?
2. $\{x_n\}_{n\in\mathbb{N}}, \quad x_{n+1} := [x_n,[a_n,x_n]]$. If $x_1 \in K(L)$, finite m-sequence?

Associative-Lie

Theorem

R associative, Φ with no 2-torsion, $K(R^-)$

1. *R prime, $R^-/Z(R)$ strongly prime.*
2. *$K(R^-)$ is the intersection of all s.p. ideals of R^-.*
3. *$K(R^-) = \pi^{-1}(Z(R/r(R)))$, $r(R)$ Baer radical of R and $\pi : R \to R/r(R)$ the canonical projection.*
4. *$K(R^-) = \{x \in R \mid m\text{-sequence in } x \text{ has finite length}\}$.*

Associative-Lie

Theorem

$(R, *)$ *associative with involution,* Φ *with no 2-torsion,* $L := \mathrm{Skew}(R, *)$ *and* $K(L)$ *Kostrikin radical.*

1. R *prime,* $L/(Z(R) \cap \mathrm{Skew}(R, *))$ *strongly prime??.*
2. $K(L)$ *is the intersection of all s.p. ideals of* L*.*
3. $K(L) = \pi^{-1}(Z(L/(r(R) \cap L)))$*,* $r(R)$ *Baer radical of* R *and* $\pi : R \to R/r(R)$ *the canonical projection.*
4. $K(L) = \{x \in R \mid$ *m-sequence in* x *has finite length*$\}$.

J Jordan algebra

- $Mc(J)$ McCrimmon radical.
- $J/Mc(J)$ nondegenerate.
- $I \triangleleft J$ nondegenerate if J/I nondegenerate.
- $I \triangleleft J$ strongly prime if J/I prime and nondegenerate.
- $Mc(J) = \bigcap_{I_\alpha \triangleleft_{\text{f.p.}} J} I_\alpha$.

1. J nondegenerate $\iff$ J subdirect product of s.p.
2. m-sequences: $\{x_n\}_{n\in\mathbb{N}}, \quad x_{n+1} := U_{x_n} a_n,$

$$x_1 \in Mc(J) \iff \exists k | x_k = 0$$

J nondegenerate: $\quad U_x J := 0 \implies x = 0$

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    - $L_x := (L/\ker(x), \bullet)$.

$$U_{\overline{a}}\overline{b} = \frac{1}{8}\overline{\mathrm{ad}_a^2\,\mathrm{ad}_x^2\,b}, \quad \text{for all } a, b \in L, \quad \text{and}$$

$$\{\overline{a}, \overline{b}, \overline{c}\} = -\frac{1}{4}\overline{[a, [\mathrm{ad}_x^2\,b, c]]} \quad \text{for all } a, b, c \in L$$

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- **Theorem:** L , $x \in L$ Jordan element

$$Mc(L_x) \subset \{\bar{a} \in L_x \mid [x, [x, a]] \subset K(L)\}.$$

Definition

- α *an ordinal. L satisfies* $\mathcal{H}_\alpha$ *if* $\beta \leq \alpha$ *not ordinal limit every submodule* $L_\beta := K_\beta(L)/K_{\beta-1}(L)$ *invariant by inner automorphisms of* L_β *is an ideal of* L_β.
- *L satisfies* $\mathcal{H}$ *if satisfies* $\mathcal{H}_\alpha, \forall\ \alpha$.

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- L Generate by ad-nilpotent elements index $\leq k$. $p > 2k - 2$
- $L = \bigoplus_{i=1}^{n} L_i$, $\mathbb{Z}$-graded $L_0 = \sum_{i=1}^{n} [L_i, L_{-i}]$. $p > 4n$

L Lie algebra with $\mathcal{H}$

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Let $x \in L$ Jordan element. Then any m-sequence on x has finite length . In particular, $Mc(L_x) = L_x$.

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Proposition

Let M an m-sequence of Jordan elements.If $P \triangleleft L$ maximal $M \cap P = \emptyset$, Then P is s.p. ideal of L.

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Papers

1. A construction of gradings of Lie Algebras. **Int. Math. Res. Not.** (2007)

Authors: E. Neher, A. Fernández López, E. García, —

Papers

1. A construction of gradings of Lie Algebras. **Int. Math. Res. Not.** (2007)
2. The Jordan Algebras of a Lie Algebra. **J. Algebra** (2007)

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1. A construction of gradings of Lie Algebras. **Int. Math. Res. Not.** (2007)
2. The Jordan Algebras of a Lie Algebra. **J. Algebra** (2007)
3. The socle of a nondegenerate Lie algebras. **J. Algebra** (2008)

Authors: . Draper, A. Fernández López, E. Garcia, —

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5. Inner ideal structure of nearly Artinian Lie algebras. **Proc. A.M.S** (2008-9)
6. A characterization of the Kostrikin radical of a Lie algebra. **preprint** (???)

Authors: A. Fernández López, E. Garcia, —