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QUASARS

I. Useful References:

"Proceedings of the Copenhagen Symposium on 'Active Nuclei'" (ed. O. Ulfbeck) 1978, Physica Scripta, vol. 17.

"Quasars" Rees, M. J. 1978, Observatory, 98, 210.

"Pittsburgh Conference on BL Lac Objects" (ed. A. M. Wolfe) 1978 (University of Pittsburgh Press).

"Active Galactic Nuclei" (ed. C. Hazard and S. Mitton) 1979 (Cambridge University Press).

"Optical and Infrared Polarization of Active Extragalactic Objects" (ed. Angel. J. R. P., and Stockton, H. S.) 1980, Ann. Rev. Astr. Ap, 18, 321.

II. Discovery of Quasars

A. 3C identifications

B. 3C 48, 3C 273

III. Definition (old)

A. stellar appearance

B. ultraviolet excess (relative to stars)

C. variable optical flux

D. broad emission lines

E. large z (large luminosity)

IV. Updating II and III above

A. Discovery by UVX, emission lines, variability, polarization, X-rays

B. Definition to accomodate BL Lacs, high-z quasars, 3C 446, Seyfert and N-galaxies, OVV's.

V. Quasar spectra

A. Radio-incoherent electron-synchrotron since polarized, VLB size, $T_b \lesssim 10^{12}$ K, power-law with SSA. ("exotic" mechanisms and low-frequency variability).

B. Near IR-optical

1. Synchrotron OVV + BL Lac since correlated radio/optical outbursts, OJ 287 constant polarization P.A., $\alpha \sim 1$ to 1.5 continuum power-law, core $\alpha_{RO} \sim +0.7$ extrapolates.

2. Reacceleration problem when $T_{var} \lesssim 10^h$, $L \gtrsim 10^{46}$ ergs s^{-1}

   a. T_{var}, $L \rightarrow U_{rad} < U_B$ or SSC $\rightarrow B \gtrsim 10^3$ gauss, $\gamma_e \lesssim 10^3$ (optical)

      $T_{synchro} \lesssim 1$ sec $<<$ T_{var}

      $T_{cyclo} \lesssim 10^3$ sec $< T_{var}$

   b. Thompson scattering, Faraday depolarization $\rightarrow N_{re\text{-}accel} > 5$, > 300, respectively

3. Most quasars - no evidence for synchrotron optical emission. (unpolarized, nonvariable, curved spectra) Could be:

   a. Dust $T_{max} \sim 10^3$K $\quad L = 10^{46} \rightarrow R \gtrsim 3$ Ly $\quad \lambda_{min} \sim 3\mu$

   b. Compton scattering from thermal or other seed photons

   c. $T \sim 10^4$ K gas $\quad r_{min} \sim 1$ light week for black body.

      3000 Å bump of Richstone and Schmidt.

4. X-ray possibly CS. radio-X-ray correlation, but exceptions exist. $T_{var} < 1$ day? (1 case)

VI. Models of energy source

A. Need $>10^{60}$ erg, stable directions for $T > 10^7$ yr to make extended radio components $\rightarrow M >> 10^6 M_\odot$

B. Size $\lesssim$1 light day for var.

C. Classes of models

   1. star clusters

   2. spinars

   3. accreting black holes