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Problem 21.43 (RHK)

Quasars are thought to be nuclei of active galaxies in the early stages of their formation. A typical quasar radiates energy at the rate of 1.20×10^{41} W. *We have to find the rate at which the mass of this quasar is being reduced in supplying this energy. We have to express our answer in units of solar mass per year, where one solar mass unit* (smu) *is the mass of our Sun.*

Solution:

The rate at which quasar is radiating energy is

$$\frac{dE}{dt} = 1.20\times10^{41} \text{ W}.$$

Therefore, the rate at which the mass of the quasar is being lost will be given by the mass-energy relation

$$E = Mc^2.$$

Thus,

$$\left|\frac{dM}{dt}\right| = \frac{1}{c^2}\frac{dE}{dt} = \frac{1.20\times10^{41}}{\left(3\times10^{8}\right)^2}\ \text{kg s}^{-1} = 1.33\times10^{24}\ \text{kg s}^{-1}.$$

We use the following data

$$\text{mass of Sun} = M_O = 1.99\times10^{30}\ \text{kg}.$$

$$1\ \text{year} = 3.156\times10^{7}\ \text{s}.$$

We thus find

$$\left|\frac{dM}{dt}\right| = \frac{1.33\times10^{24}\times3.15\times10^{7}}{1.99\times10^{30}}\ \text{smu y}^{-1},$$

$$= 21.3\ \text{smu y}^{-1}.$$