ASSIGNMENT- 7

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Gravitational redshift for distant observer

a) $\lambda_e = 6563\ \text{Å}$ (H-α) $\quad \Phi = -\frac{GM}{r} \sim -10^{-6}$ (rest source) – ~~Star~~ Typical Star

We know, $\lambda_o = \frac{\lambda_e}{\left(1 - \frac{2GM}{r}\right)^{1/2}} = \frac{\lambda_e}{\left(1 - 2\times10^{-6}\right)^{1/2}} \approx \frac{6563}{\left(1 - 2\times10^{-6}\right)^{1/2}}\ \text{Å} \approx \boxed{6563.007\ \text{Å}}$

b) $\Phi = -6\times10^{-5}$ (White dwarf)

Then, $\lambda_o = \frac{\lambda_e}{\left(1 - \frac{2GM}{r}\right)^{1/2}} = \frac{6563\ \text{Å}}{\left(1 - 2\times 6\times10^{-5}\right)^{1/2}} \approx \boxed{6563.394\ \text{Å}}$

c) Source at $r = 1.1\, r_s$ and mass $1\, M_\odot$

Then, $\frac{GM}{r} = \frac{GM}{1.1\, r_s} = \frac{GM}{1.1\,(2GM)} = \frac{1}{1.1\times2}$

So, $\frac{2GM}{r} = \frac{1}{1.1}$

Now, $\lambda_o = \frac{\lambda_e}{\left(1 - \frac{2GM}{r}\right)^{1/2}} = \frac{6563\ \text{Å}}{\left(1 - \frac{1}{1.1}\right)^{1/2}} \approx \boxed{21767.008\ \text{Å}}$

d) Source at ~~r =~~ $r = 1.01\, r_s$ and mass $1\, M_\odot$

Then, $\frac{2GM}{r} = \frac{2GM}{1.01\, r_s} = \frac{2GM}{1.01\,(2GM)} = \frac{1}{1.01}$

So, $\lambda_o = \frac{\lambda_e}{\left(1 - \frac{2GM}{r}\right)^{1/2}} = \frac{6563\ \text{Å}}{\left(1 - \frac{1}{1.01}\right)^{1/2}} \approx \boxed{65957.334\ \text{Å}}$