1 Solar S

The gravitational acceleration of an object is given by Newtons law of gravitation as

$$g(r) = \frac{GM(r)}{r^2}, \tag{1}$$

where $M(r)$ is the enclosed mass, $G = G = 6.6743 \cdot 10^8$ [cm^3/gs^2] is the gravitational constant and r is the distance from the centre of mass. We rename this as $r \to rR_*$, where R_* is the radius of the sun since the solar S data is in r/R_*. Then the gravitational law is

$$g(r) = \frac{GM(r)}{R_*^2 r^2}. \tag{2}$$

The enclosed mass is

$$M(r) = \int_0^r dm = \int_0^r = 4\pi R_*^3 \int_0^r \rho(r')dV = \int_0^r \rho(r')r'^2 dr' \tag{3}$$

We discretize this and use the trapezoidal method of integration and get

$$M(r_{i+1}) = 4\pi R_*^3 \frac{1}{2}(\rho_{0,(i+1)} r_{i+1}^2 - \rho_{0,(i)} r_i^2)(r_{i+1} - r_i). \tag{4}$$

Inserting this in the equation for gravitational acceleration gives

$$g(r_{i+1}) = \frac{4\pi R_* G}{r_{i+1}^2} \frac{1}{2}(\rho_{i+1} r_{i+1}^2 - \rho_i r_i^2)(r_{i+1} - r_i) \tag{5}$$