

- **nsagrav: NS H atmosphere model for different g**

This model provides the spectra emitted from a nonmagnetic hydrogen atmosphere of a neutron star with surface gravitational acceleration g ranging from $1e13$ to $1e15$ cm/s^2 , allowed by equations of state for the neutron star matter (the **nsa** model gives the spectra calculated for $g=2.43e14$ cm/s^2). The uniform surface (effective) temperature is in the range of $\text{Log } T_{\text{eff}}(\text{K}) = 5.5 - 6.5$. The atmosphere is in radiative and hydrostatic equilibrium; sources of heat are well below the atmosphere. The radiative force and electron heat conduction are included in the models, but they are of no importance in the specified ranges of T_{eff} and g . The model spectra are provided as seen by a distant observer, with allowance for the GR effects.

The neutron star mass M and radius R determine the redshift parameter,

$$g_r = [1 - 2.952 * M/R]^{0.5},$$

and the gravitational acceleration at the surface,

$$g = 1.33e16 * M/R^2 / g_r \text{ cm/s}^2,$$

where M is in units of solar mass, and R is in km. The allowed domain in the M - R plane corresponds to $g_r^2 > 1/3$ and $1e13 < g < 1e15$ cm/s^2 . (This domain is restricted by the solid curves in the figure). If chosen M and R values correspond to g_r or/and g values outside the allowed domain, then the code sets the latter to be the closest limiting values (e.g., if one chooses $M=2$, $R=8$, then the code will use $g_r=3^{-1/2}=0.578$ instead of $g_r=0.512$ corresponding to the M and R chosen), which would lead to unphysical results.

The values of the effective temperature and radius as measured by a distant observer ("values at infinity") are:

$$T^\infty = g_r T_{\text{eff}}, R^\infty = R / g_r$$

The nsagrav model may be useful for putting constraints on M and R from spectral fits to thermal emission detected from neutron stars, provided the quality of the observational data are good enough to warrant a detailed analysis. The parameters M and R can be fixed at specific values or allowed to vary within a reasonable range (see the note above). For example, one can run spectral fits on a M - R grid (using the **steppar** command) within the allowed parameter domain (see above).

Please send your comments/questions (if any) to Slava Zavlin (vyacheslav.zavlin@msfc.nasa.gov) and/or George Pavlov (pavlov@astro.psu.edu). If you publish results obtained using this model please reference Zavlin et al. (1996, A&A 315, 141).

par1 Log T_{eff} : (unredshifted) effective temperature

par2 M_{ns} : neutron star gravitational mass (in units of Solar mass)

par3	R_{ns} : “true” neutron star radius (km)
K	$1/D^2$ where D is the distance to the object in pc