Within a project of the IUCr Commission on Charge, Spin & Momentum Densities on vanadium metal a full set of room temperature structure factors up to \( \sin \theta / \lambda \leq 1.1 \) have been measured using 316.4, 411.8, 468.0 and 604.4 keV \( \gamma \)-radiation from radioactive Au-198 and Ir-192.

In a first step the temperature dependence of the structure factor anisotropy for the pairs of reflections 330/441 and 442/600 has been measured over the range from 70 to 800 K. The low temperature data agree well with earlier X-ray scattering results (Diana & Marzone, Phil. Mag. 1975 32:1227) and confirm a deformation of the atomic 3d charge distribution in the solid which points towards the nearest neighbours in the bcc lattice. At higher temperatures the anharmonic motion towards the next-nearest neighbours first cancels the effect of the electronic anisotropy and finally dominates the measured structure factor anisotropy for the 442/600 pair of reflections. The temperature dependence of the lattice parameter was measured using the X-ray Bond method and no indication for a significant amount of impurities was found. The parameters \( a \), \( b \) and \( c \) of the one-particle potential which describes the thermal motion of the atoms, were determined by analysing the temperature dependence of the absolute 442 structure factor. All measured intensities were corrected for thermal diffuse scattering.

The low order structure factors were measured on two samples showing different amounts of extinction, but the wavelength extrapolation to the limit of zero extinction provided identical structure factor values for both samples. The experimental data are compared with the results of density-functional calculations within the local-density approximation to the exchange-correlation energy functional (e.g.: Laurent, Wang & Callaway, Phys. Rev. B113:7839, 1977). The agreement between experiment and theory is reasonable, remaining differences are discussed in terms of difference charge density maps.