with a and b determined from the (velocity averaged) annihilation cross section, expanded in powers of momentum, $\langle v\,\sigma_{X\overline{X}}\,\rangle = a + \frac{1}{6}b\,\langle v^2\rangle_f$, at freezeout temperature T_f ($\langle v^2\rangle_f = 6T_f/M_X$) at which the X's drop from thermal equilibrium (typically $T_f \approx \frac{1}{20}M_X$). In Eq. (4.1), N_F is the total number of relativistic degrees of freedom at T_f and (T_X/T_γ) is the ratio of the temperatures of X's and photons at T_f. In the halo of our galaxy $\langle v^2\rangle \approx 10^{-6}$, thus $\langle v\,\sigma_{X\overline{X}}\,\rangle_{\rm halo}$ and Ω_X are closely related.

Several proposals or experiments exist to detect cold dark matter candidates. For the case of heavy ($M \gtrsim 1$ GeV) particles, elastic scattering from nuclei would produce nuclear recoils with energies of $\gtrsim 1$ keV, and several techniques have been proposed to detect these recoils. The expected collision rate for a target nucleus mass m_N is:

$$R = 4.3\ \text{kg}^{-1}\ \text{day}^{-1}\left(\frac{1\ \text{GeV}^2}{m_N\ m_x}\right)\left(\frac{\sigma_{\rm el}}{10^{-38}\ \text{cm}^2}\right) \times \left(\frac{\rho^{\rm DM}}{0.3\ \text{GeV cm}^{-3}}\right)\left(\frac{\langle|v_E|\rangle}{300\ \text{km s}^{-1}}\right), \tag{4.2}$$

where $\langle|v_E|\rangle$ is the average velocity at which they strike the detector. Since crossing symmetry relates $\sigma_{\rm el}$ to $\sigma_{X\overline{X}}$, R is closely related to Ω_X. Dirac neutrinos (and sneutrinos) with masses 0.012–4.7 TeV have already been excluded by searches done using double-β decay detectors [12]. Axions could be detected by their expected coherent conversion to microwave photons in a tuned cavity. Products of DM annihilation in the halo (*e.g.*, cosmic ray $\overline{p}$'s, e^+'s, γ's) and the core of the Sun (ν's) would indirectly signal the existence of particle DM. The absence of a signal in high energy solar-ν searches using underground detectors rules out sneutrinos whereas cosmic ray searches do not constrain theory so far. Experimental limits concerning a number of dark matter candidates are given in the Full Listings. See the index under "Dark matter limits."

Recent LEP results when combined with the above experimental constraints now completely eliminate massive 4th-generation neutrinos or sneutrinos as dark matter candidates. Sneutrinos and additional Dirac and Majorana neutrinos with masses $\lesssim 40$ GeV are excluded by LEP. This alone eliminates a Majorana neutrino, since the relic abundance for the neutrinos with masses $\gtrsim 40$ GeV would be $\Omega h^2 \lesssim 2 \times 10^{-3}$, making them cosmologically uninteresting. In the case of Dirac neutrinos, if there were a density asymmetry between ν and $\overline{\nu}$, it would in principle be possible to have a cosmologically interesting density even though $m_\nu > 40$ GeV. However, as described in the previous paragraph, Dirac neutrinos (and sneutrinos) below 4.7 TeV are ruled out by direct cold dark matter searches.

For all references, see the full *Review.*