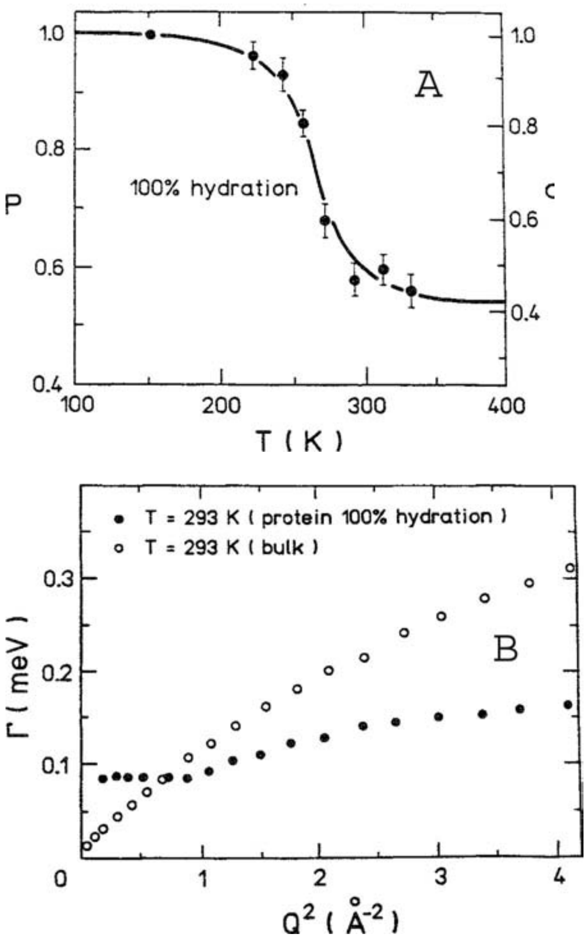

FIGURE 8 (**A**) The variation of the measured *P* parameter and of the fraction of "immobile water" *q* versus *T* for the fully hydrated C-phycocyanin (h = 0.5 g water/g protein). (**B**) Half-width at half maximum of the Lorentzian quasi-elastic line (Γ) versus Q^2, for $T = 293$ K for the fully hydrated C-phycocyanin and for the bulk water. *Source*: From Ref. 58.

way: at hydrophilic sites of protein, water molecules form relatively stable hydrogen bonds which keep the molecules confined in a small region of the surface of the protein. Water molecules alternatively form hydrogen bonds with the hydrophilic sites and their characteristic lifetime is longer than in bulk water. At the time scale of the neutron-scattering experiment, the dynamics of hydrogen bond formation concerns only three bonds among the four possible intermolecular bonds, one of them being "blocked" by the hydrophilic site of the protein.

The behavior that we describe appears very general, at least qualitatively. Hydration water from other biomolecules, as well as water confined into small pores, shows a similar slowing down of dynamic properties and a decrease of the temperature at which all the diffusive motions are frozen (59,79,83).

The common features arising from quasi-elastic neutron-scattering studies of water at a Vycor surface or close to a more complex protein surface are presented below. In particular, results of a C-phycocyanin protein at a hydration level, $h = 0.4$, are important since a monolayer coverage of water molecules