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Prions are infectious proteins hypothesized to be the causative agent of diseases such as Creutzfeld-Jakob disease in humans, scrapie in sheep, and bovine spongiform encephalopathies in cows (mad cow disease). This hypothesis is controversial, because prion populations are capable of proliferation, even though prions do not contain DNA or RNA. A mathematical population model is analyzed to explain prion proliferation. The population consists of string-like polymers formed from thousands of abnormal prion monomers. The population is structured by the length of the polymers, which is taken as a continuous variable. The model consists of a system of coupled nonlinear ordinary and partial differential equations, which describes the processes of polymer lengthening by attachment of monomers, the splitting of polymers into two smaller lengths, and the degradation of polymers. An analysis is given for the existence and asymptotic behavior of solutions. (Received February 26, 2004)