ons [7], and for 40 MeV alpha particles [2]. All show a dip for nickel. In addition, the isotopic σ_R data of fig. 2 have been averaged to reproduce the natural abundances, and are plotted on fig. 1. Similarly, the averaged optical model predictions of ref. 10 have been calculated and plotted on fig. 1. Both reproduce the dip near nickel.

In fig. 1 a plot of the average neutron number $\bar{N}$ versus atomic number shows that the average value of N for nickel is relatively small. The 14.5 MeV σ_R measurements indicate that the reason for the dip for naturally occurring isotopes near nickel is the consequence of the high stability and consequent high percentage of a relatively light isotope in nickel.

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T-FORBIDDEN EXCITATION OF ISOBARIC ANALOGUE STATES IN THE ^{37}Cl(p, α_0)^{34}S REACTION

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The analogues of the two lowest levels of ^{38}Cl, with $J^\pi = 3^-$ and 5^-, were excited in the T-forbidden reaction ^{37}Cl(p, α_0)^{34}S. The $J^\pi = 3^-$ analogue state is split into several components which form a micro-giant resonance.

The ground state and lowest three excited states of ^{38}Cl have $J^\pi = 2^-$, 5^-, $(3)^-$ and $(4)^-$, respectively [1], and $T = 2$. The analogue states in ^{38}Ar, expected at excitation energies between 10.6 and 12.0 MeV, should appear as resonances in the reactions ^{37}Cl+p in the range E_p = 0.4 - 1.8 MeV. The $J^\pi = 5^-$ doublet, found in the ^{37}Cl(p, γ)^{38}Ar reaction at E_p = 1088 and 1092 keV, was interpreted [2] as the split analogue of ^{38}Cl(1).

The excitation of $T = 2$ resonances in the ^{37}Cl(p, α_0)^{34}S reaction is T-forbidden since ^{34}S(0) has $T = 1$. According to Wigner [3], however, the strength of the $T = 2$ analogue state should be distributed over neighbouring $T = 1$ states. This letter reports the experimental observation in the reaction ^{37}Cl(p, α_0)^{34}S of the enhancement of $T = 1$ resonance strengths by $T = 2$ analogue states, which gives rise to a micro-giant resonance structure. Due to momentum and parity conservation, only the natural parity analogue states ($J^\pi = 3^-$ and 5^-) can be excited in the ^{37}Cl(p, α_0)^{34}S reaction.

The experiment, which will be described in detail in ref. 4, was performed with the Utrecht 3 MV Van de Graaff accelerator. With a thin Ba^{37}Cl$_2$ target on carbon backing the resonance curve was measured with a overall energy resolution of 1.5 keV. The strengths were measured of 130 resonances in the range E_p = 0.85 - 1.95 MeV. Angular distribution measurements on 77 strong and well-isolated resonances led to unique J^π assignments in 28 cases and to two possible J^π values in most other cases.

Due to the positive reaction Q values, Γ_p will in general be small compared to Γ_{α_0} for $E_p \lesssim 1.5$ MeV. Since also $\Gamma_\gamma \ll \Gamma_{\alpha_0}$, the resonance strength $\Gamma_p\Gamma_{\alpha_0}/\Gamma$ about equals Γ_p. The simple configurations of the analogue resonances imply

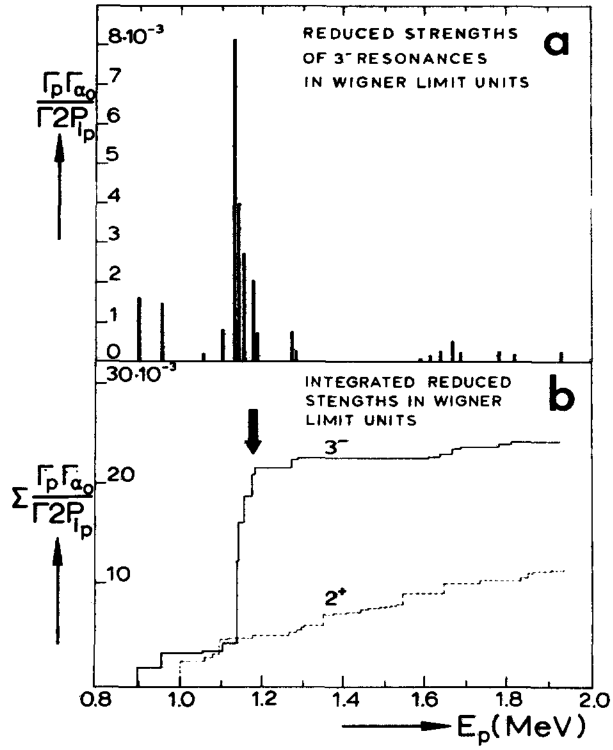

Fig. 1 (a) Reduced resonance strengths of 3^- resonances in the ^{37}Cl(p,α_0)^{34}S reaction. (b) Integrated reduced resonance strengths of 3^- and 2^+ resonances (full-drawn and dashed line, respectively).

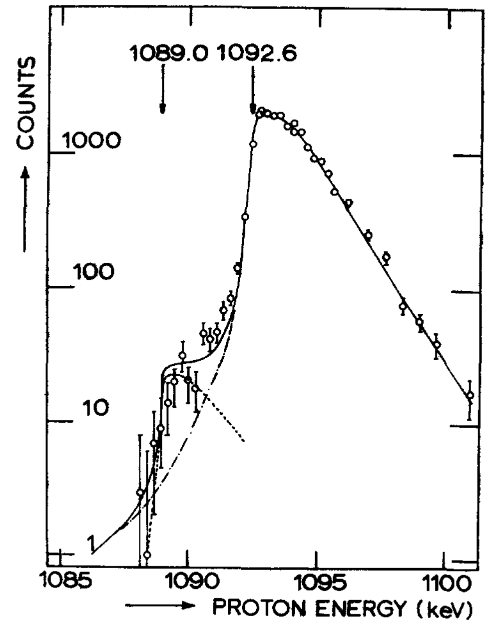

Fig. 2. The ^{37}Cl(p,α_0)^{34}S yield curve in the region of the $J^\pi = 5^-$ analogue resonances.

large proton widths relative to those of neighbouring resonances. Therefore the analogue resonances are expected to stand out as relatively strong resonances in the yield curve, if T mixing occurs.

The reduced strengths, $\Gamma_p\Gamma_{\alpha_0}/(2\Gamma P_{l_p}) \approx$ $\approx \Gamma_p/2P_{l_p}$, where P_{l_p} is the proton penetrability for orbital momentum l_p, are plotted as a function of E_p for all observed 3^- resonances in fig. 1a. A micro-giant resonance structure emerges distinctly. In fig. 1b, the drawn line represents the integrated reduced strengths of the 3^- resonances; the dotted line is a similar plot for the 2^+ resonances. The jump in the integrated 3^- resonance strengths at $E_p = 1.14$ MeV has no comparable counterpart in the 2^+ curve. This conclusion does not change if one takes into account possible distortions of the curves due to the fact that the J^π values were not measured for all the observed resonances, either since they were too weak or since doublets could not be resolved. An extra distortion may arise for $E_p \gtrsim 1.5$ MeV, since there the assumption $\Gamma_p \ll \Gamma_{\alpha_0}$ may be invalid.

The energy difference between ^{38}Cl(1) and (2) is 85 keV [1]. The analogue state of ^{38}Cl(1) was found [2] at $E_p = 1090$ keV. Therefore the analogue of ^{38}Cl(2) can be expected at $E_p \approx 1175$ keV. This energy (see arrow in fig. 1b) is in fair agreement with the energy of the jump in the 3^- strength curve, although in principle the centroid of the enhanced $T = 1$ resonances needs not coincide exactly with the energy of the $T = 2$ analogue state.

The shape of the micro-giant resonance gives some evidence for the predicted [5] asymmetry. In this respect, the gap between $E_p = 1280$ and 1585 keV is remarkable. A fit to Robson's cross section formula [5], however, requires an unacceptably large giant resonance width. This might be due to the fact that the theory is formulated for $\Gamma_p \approx \Gamma$, which is certainly not true in this case.

The spectroscopic factor of ^{38}Cl(2) for $l_p = 1$ and 3 was determined [1] from the ^{37}Cl(d,p)^{38}Cl reaction as $S_1 = 0.09$ and $S_3 = 0.59$, respectively. These numbers lead to a f-capture contribution to the (p,α_0) resonances of less than 4%. This is confirmed in this experiment. The integrated reduced proton width of the 3^- resonances in the (p,α_0) reaction should be approximately $\theta_p^2 = \frac{1}{4}S_1 =$ $= 0.023$, where the factor $\frac{1}{4}$ arises from isospin vector coupling. The step in the integrated strengths curve amounts to $\theta_p^2 = 0.019$ (for E_p = = 1.0 - 1.3 MeV), in good agreement with the value calculated from the (d,p) experiment.

Recently, our interpretation of the 3^- resonances as split analogues of ^{38}Cl(2), was strengthened by the observation [6] that the main component at E_p = 1138 keV strongly decays to the $J^\pi = 3^-$ anti-analogue states at ^{38}Ar* = 3807 and 4873 keV.

The detection of the $J^\pi = 5^-$ analogue states in the (p, α_0) reaction met with some experimental difficulties. The (p, γ) and (p, α_0) yields were measured simultaneously. A strong (p, α_0) resonance ($J^\pi = 1^-$ or 2^+) occurs between the two $J^\pi = 5^-(p, \gamma)$ resonances. Using the present energy calibration the (p, γ) resonances are labelled as E_p = 1089.0 and 1094.2 keV and the (p, α_0) resonance as E_p = 1092.6 keV. The (p, α_0) yield curve in the neighbourhood of the latter resonance, measured with good statistics, is given in fig. 2 (background subtracted). A distinct structure is observed at the foot of the strong (p, α_0) resonance. The dot-dash line gives the shape of a single resonance, as measured with the same target at E_p = 1138 keV. The drawn line is a fit to the measured points, assuming resonances at E_p = 1089.0 and 1092.6 keV, which both have the shape of the 1138 keV resonance. The higher resonance of the $J^\pi = 5^-$ doublet, at 1094.2 keV, is obscured by the tail of the strong 1092.6 keV resonance.

In the literature the excitation of a resonance in a (p, α) reaction was sometimes applied as a criterion for T assignments. This investigation, in which the (p, α) reaction is used as a tool in the study of analogue states, shows that T assignments based on (p, α) studies should be considered with some care.

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MASSES OF NUCLEI WITH $Z > N$ *

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A phenomenological relation between ground-state atomic masses in conjunction with charge symmetry is used to investigate all the masses of nuclei with $A \leq 42$ with $Z > N$. In cases where experimental data exist the agreement with the predictions is good.

Extensive and accurate measurements of masses of neutron deficient light nuclei, have been recently carried out [1-4]. Many techniques exist for estimating the masses of these nuclei with proton excess if one [5-8] or more [9] members of the same isospin multiplet are known.

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