Adopted Levels

Q(β^-)=−17.39×10^3 *15*; S(n)=17.35×10^3 *15*; S(p)=−1.25×10^3 *11*; Q(α)=−9.34 *12* 2012Wa38

All experimental evidence is consistent with the scenario that all levels of ^{18}Na proton decay 100% to levels in ^{17}Ne.

Existing evidence suggests a ground state near E_{res}(cm)=1.25 MeV (Γ≈0.54 MeV) inspite of evidence for a resonance that decays with E_{cm}(p+^{17}Ne)=0.41 MeV *16* (Γ≈340 keV). The later strength is likely a higher energy state that decays to a ^{17}Ne excited state, hence the resonant decay energy does not trivially reflect the excitation energy or missing mass. Wang and Audi et al. take ΔM=25040 keV *110* [E_{cm}(p+^{17}Ne)=1.25 MeV *11*] as the ground state energy; we accept the ^{18}Na ground state at S_p=1.25 MeV *11* (2012Wa38).

Theoretical works:

Using analysis of the mirror ^{18}N system, frameworks are developed describing the low-lying levels of ^{18}Na in terms of ^{19}Na plus a neutron hole (2005Fo13) or ^{17}Ne plus a proton (2006Fo08). Estimates on the mass excess and level spacings are discussed. In (2012Fo10) the approach was updated using newly available data.

See other analyses in (1928Gu10, 1984An18, 1987Po01, 2004Ge02, 2008Qi04).

^{18}Na Levels

Cross Reference (XREF) Flags

A ^{1}H(^{17}Ne,p)
B ^{9}Be(^{20}Mg,P17NE)

E(level)	J$^\pi$	$T_{1/2}$	XREF	Comments
0	(1)$^-$	<0.2 MeV	B	%p≈100. Excitation energies are reported with respect to E_{res}(p+^{17}Ne)=1.25 MeV *11*, the accepted value in (2012Wa38). $T_{1/2}$: <0.2 MeV (2012Mu05); also see Γ=0.48 MeV *14* (2004Ze05).
0.30×10^3 *11*	2$^-$	5 keV *3*	AB	%p≈100. E(level): from E_{res}(p+^{17}Ne)=1552 keV *5*.
0.59×10^3 *12*	0$^-$	300 keV *100*	A	%p≈100. E(level): from E_{res}(p+^{17}Ne)=1842 keV *40*.
0.78×10^3 *11*	1$^-$	900 keV *100*	A	%p≈100. E(level): from E_{res}(p+^{17}Ne)=2030 keV *20*.
0.83×10^3 *11*	3$^-$	42 keV *10*	A	%p≈100. E(level): from E_{res}(p+^{17}Ne)=2084 keV *5*.

$^1H(^{17}Ne,p)$ 2012As04

The level structure of ^{18}Na was studied by ^{17}Ne+p elastic scattering, in inverse kinematics, with the aim of adding understanding to the dynamics of 2p decay of ^{19}Mg.

A beam of E(^{17}Ne)=4 MeV/nucleon ions from the SPIRAL facility at GANIL impinged on a polypropylene (C_3H_6) target assembly. The target assembly consisted of a fixed 50 μg/cm^2 C_3H_6 foil followed by a rotating (1000 rpm) C_3H_6 foil which stopped the beam and carried away the beams undesired decay radiation; scattered protons are unaffected by the target functionality.

The scattered protons, whose energies are convoluted with the target thicknesses and the scattering excitation function, were detected at $5°\leq\theta_{lab}\leq20°$ with a annular position sensitive ΔE-E telescope. The scattering excitation function, which is assumed to result from elastic scattering, is deduced with an energy resolution of 13 keV. Small backgrounds from reactions on ^{12}C and β-delayed protons from ^{17}Ne are evaluated and subtracted from the proton energy spectrum. Finally the spectrum is evaluated via R-matrix analysis. Two peaks are prominent; the later apparently corresponding to a narrow $J\pi=3^-$ resonance with interference from two broad s-wave resonances.

The deduced level structures are compared with shell-model predictions. Interpretation suggests two narrow states that are predicted in the shell model, the 1^- ground state and a 2^- excited state, are too weakly populated to be observed.

An earlier experiment utilizing a 150 μg/cm^2 C_3H_6 foil (2011As07,2011AsZX) produced similar results.

^{18}Na Levels

E(level)	J^π	Γ	Comments
0.30×10^3 *11*	2^-	5 keV *3*	%p≈100. E(level): from E_{res}=1552 keV *5* and $^{18}Na_{g.s.}$ with S_p=1.25 MeV *11*. Γ: for Γ_0 to $^{17}Ne_{g.s.}$; there is a limit of Γ<1 keV for decay to ^{17}Ne excited states.
0.59×10^3 *12*	0^-	300 keV *100*	%p≈100. E(level): from E_{res}=1842 keV *40* and $^{18}Na_{g.s.}$ with S_p=1.25 MeV *11*. Γ: for Γ_0 to $^{17}Ne_{g.s.}$; there is a limit of Γ<10 keV for decay to ^{17}Ne excited states.
0.78×10^3 *11*	1^-	900 keV *100*	%p≈100. E(level): from E_{res}=2030 keV *20* and $^{18}Na_{g.s.}$ with S_p=1.25 MeV *11*. Γ: for Γ_0 to $^{17}Ne_{g.s.}$; there is a limit of Γ<100 keV for decay to ^{17}Ne excited states.
0.83×10^3 *11*	3^-	42 keV *10*	%p≈100. E(level): from E_{res}=2084 keV *5* and $^{18}Na_{g.s.}$ with S_p=1.25 MeV *11*. Γ: for Γ_0 to $^{17}Ne_{g.s.}$; there is a limit of Γ<1 keV for decay to ^{17}Ne excited states.

^{9}Be(^{20}Mg,P17NE) 2012Mu05

There are two experiments that utilized nucleon knockout reactions on ^{20}Mg to populate states in ^{18}Na. The first work was carried out at 43 MeV/nucleon (2004Ze05) and focused on a reconstruction of the p+^{17}Ne invariant mass spectrum. The second effort was carried out at 450 MeV/nucleon and focused on analysis of the p_1-^{17}Ne, p_2-^{17}Ne and p_1-$p_2$particle correlations following population of ^{19}Mg states and their subsequent two-proton decays, which have branches that proceed sequentially through levels in ^{18}Na. The ground state of ^{18}Na was observed in both experiments.

2004Ze05:

The discovery of ^{18}Na is credited to (2004Ze04). A beam of 43 MeV/nucleon ^{20}Mg ions was produced by fragmenting a ^{24}Mg beam on a thick ^{12}C target using the ALPHA spectrometer and SISSI solenoids at GANIL. The beam was transported to the SPEG spectrometer where it impinged on a 47 mg/cm^2 ^{9}Be foil in the target position. Light ion ejectiles were detected in the position sensitive Si/CsI ΔE-E MUST array, while heavier ions were detected in spectrometer focal plane detectors. The invariant mass spectrum was generated for each p+17Ne pair observed in the experiment. The resulting spectrum indicated two peaks that are attributed to proton decay from ^{18}Na to ^{17}Ne.

The two peaks are consistent with mass excesses of 24.19 MeV *16* and 25.04 MeV *17*. The interpretation of the two peaks remains unclear since no γ-ray detectors were used in the measurement; this missing information creates an ambiguity in interpretation for the case where a level in ^{18}Na decays to an excited state of ^{17}Ne. Significant discussion on the determination of the ground state level and assignment of Jπ values is given in the article.

The prefered analysis accepts the ground state mass excess of 25.04 MeV *17* with Γ=0.48 MeV *14* and Jπ=1$^-$ (by comparison with ^{18}N). The peak appearing in the invariant mass spectrum at 24.19 MeV *16* with Γ=0.23 MeV *10* is attributed to decay from an excited state of ^{18}Na to and excited state of ^{17}Ne; in this case the experiment doesn't provide sufficient information to assign an energy to the ^{18}Na level.

2012Mu05:

The authors measured the decay of proton unbound states in ^{19}Mg and ^{18}Na by fragmenting a ^{20}Mg beam in a ^{9}Be target and analyzing the p_1-p_2, p_1-^{17}Ne and p_2-^{17}Ne particle correlations.

A beam of ^{20}Mg ions (produced by fragmenting a 450 MeV/A ^{24}Mg beam) impinged on a 2 g/cm^2 ^{9}Be target at the midplane of the GSI FRS. The target was surrounded by an array of four position sensitive detector telescopes that measured the breakup charged particle angular correlations (p_1-p_2, p_1-^{17}Ne and p_2-^{17}Ne). Two prominent peaks appear in the p-^{17}Ne angular correlation distribution; first is a peak consistent with 2p decay of the $^{19}Mg_{g.s.}$ directly to ^{17}Ne+2p with E_{res}=0.75 MeV *5*, second is a peak corresponding to ^{19}Mg excited states decaying sequentially through proton unbound states in ^{18}Na.

The excited states in ^{19}Mg appear as "arc bands" in the θ(p_1-^{17}Ne) vs. θ(p_2-^{17}Ne) angular correlation spectrum. Analysis of events along a fixed or constant radius provides details about the initial ^{19}Mg state and the ^{18}Na states populated in the sequential decay to $^{17}Ne_{g.s.}$+2p. Evidence for two states is visible in the spectrum. Monte Carlo simulations are used to extract "best fit" values for energies and widths of ^{19}Mg and ^{18}Na states.

Finally arguments based on the extracted widths and the Wigner Limits are used to constrain Jπ values.

Also see earlier analysis of data in (2008Mu13).

See (2003Gr01) for further discussion on the role of ^{18}Na states in ^{19}Mg 2p decay.

^{18}Na Levels

E(level)	J$^\pi$	Γ	Comments
0	(1)$^-$	<0.2 MeV	%p≈100. In (2012Mu05) E_{res}(p+^{17}Ne)=1.23 MeV *15* while (2004Ze05) report 1.27 MeV *17*. Excitation energies are reported with respect to 1.25 MeV *11*, the accepted value in (2012Wa38). Γ: <0.2 MeV (2012Mu05); also see Γ=0.48 MeV *14* (2004Ze05).
0.30×10^3 *13*	2$^-$	0.25 MeV *25*	%p≈100. from E_{res}(p+^{17}Ne)=1.55 MeV *7* (2012Mu05) and $^{18}Na_{g.s.}$=E_{res}(p+^{17}Ne)=1.25 MeV *11*. Γ: 0.25 MeV *+25−15* (2012Mu05).
0.83×10^3?	3$^-$		from E_{res}(p+^{17}Ne)=2.084 MeV from (2011AsZX) and $^{18}Na_{g.s.}$=E_{res}(p+^{17}Ne)=1.25 MeV *11*. This state is not conclusively observed; however in (2012Mu08) including this Jπ=3$^-$ state at Q(p+^{17}Ne)=2.084 MeV permits a quantitative reproduction of the correlation spectra.

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