[[File:Nucleus drawing.svg|thumb|right|[[原子核]]是密集的一綑核子組成的：[[質子]]（紅）及[[中子]]（藍）。圖中的質子和中子像粘在一起的小球體，但根據現代[[核物理學]]，實際的核子卻非如此。要準確描述真實的原子核，我們需要用到[[量子力學]]。例如，在真的原子核裏，每個核子都同時處於多個位置，充斥著整個原子核。]]

在[[化學]]和[[物理學]]裏，'''核子'''是組成[[原子核]]的一個粒子。每個原子核都有至少一個核子，而至少一個電子圍繞著它，從而組成一個原子。核子共有兩種：[[中子]]和[[質子]]。某種同位素的[[原子量]]就是其核子的總數。因此有時人們也會稱這個數字為核子數。

在1960年代之前，核子被認為是[[基本粒子]]，不是由更小的部份組成的。今天我們知道核子是[[粒子列表#複合粒子|複合粒子]]，由三個[[夸克]]經[[強相互作用]]綑綁組成。兩個或以上核子之間的交互作用稱為[[核力]]，最終這也是強交互作用引起的。（在發現夸克之前，「強交互作用」一詞只用於核子間的交互作用。）

核子是[[粒子物理學]]和[[核物理學]]領域交界之處。粒子物理學，特別是[[量子色動力學]]，提供的是解釋夸克及強交互作用屬性的公式。這些公式能夠用量化的方法解釋夸克是如何結合成為中子和質子（以及所有其他的[[強子]]）的。然而，當多個核子聚集成一個原子核（[[核素]]）時，這些基礎方程式就非常難直接求解了。取而代之的是核物理學，它利用近似法和模型來研究多個核子之間的交互作用，例如用[[核殼層模型]]。這些模型能夠準確解釋核素的屬性，比如哪些核素會進行[[核衰變]]等。

質子和中子均同時為[[重子]]和[[費米子]]。用粒子物理學的術語來說，它們組成一個[[同位旋|同位旋雙重線]]（{{nowrap|'''I''' {{=}} {{frac|1|2}}}}）。這就是為甚麼它們的質量如此相近：中子的質量比質子高僅僅0.1%。

==概述==

{{main|質子|中子}}

===屬性===

{{multiple image

| align = right

| direction = vertical

| header = 組成核子的[[夸克]]

| width1 = 128

| image1 = Quark structure proton.svg

| alt1 = 質子

| caption1 = 質子（{{SubatomicParticle|proton}}）：{{SubatomicParticle|Up quark}}{{SubatomicParticle|Up quark}}{{SubatomicParticle|Down quark}}

| width2 = 128

| image2 = Quark structure neutron.svg

| alt2 = 中子

| caption2 = 中子（{{SubatomicParticle|neutron}}）：{{SubatomicParticle|Up quark}}{{SubatomicParticle|Down quark}}{{SubatomicParticle|Down quark}}

| width3 = 128

| image3 = Quark structure antiproton.svg

| alt3 = 反質子

| caption3 = 反質子（{{SubatomicParticle|antiproton}}）：{{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Down antiquark}}

| width4 = 128

| image4 = Quark structure antineutron.svg

| alt4 = 反中子

| caption4 = 反中子（{{SubatomicParticle|antineutron}}）：{{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Down antiquark}}{{SubatomicParticle|Down antiquark}}

}}

質子和中子是原子核的組成部份，也能夠在不組成原子的情況下單獨存在。獨立存在的質子就是[[氫-1]]（<sup>1</sup>H）的原子核。單獨的中子是不穩定的（見下），但可以在核反應中出現，並在科學分析範疇派上用場。

質子和中子均由三個夸克組成。質子由2個[[上夸克]]和1個[[下夸克]]組成，而中子則由1個上夸克和2個下夸克組成。這些夸克受[[強相互作用]]的綑綁。另一說法是，夸克是受[[膠子]]捆綁的，但實際上兩種說法是等同的（膠子傳遞強相互作用）。

每個上夸克的[[電荷]]為+{{frac|2|3}}&nbsp;[[基本電荷|e]]，而每個下夸克的電荷為−{{frac|1|3}}&nbsp;e，所以質子和中子的總電荷分別為+e和0。「中子」一詞便源自其電「中性」的屬性。

質子和中子的質量相當：質子的為{{val|1.6726|e=-27|ul=kg}}或{{val|938.27|ul=MeV/c2}}，而中子的則為{{val|1.6749|e=-27|ul=kg}}或{{val|939.57|ul=MeV/c2}}。中子相對較重大約0.1%。兩者質量的相近能夠通過[[粒子物理學]]中的[[同位旋]]近似對稱來解釋（見下）。

質子和中子的[[自旋]]為{{frac|1|2}}。這意味著它們是[[費米子]]而非[[玻色子]]，因此與[[電子]]一樣，它們也遵守[[包利不相容原理]]。這在[[核物理學]]中是非常重要的：一個原子核中的中子和質子不能同時佔據相同的[[量子態]]，而是會分散開來形成[[核殼層]]，這和化學中電子形成[[電子殼層]]的原理相似。質子和中子自旋的重要性也在於，它是大原子核的核自旋的來源。核自旋的其一重要應用在於化學和生化分析中的[[核磁共振成像]]。

質子的[[磁矩]]，寫作μ<sub>p</sub>，是{{val|2.79|u=[[核磁子]]（&mu;<sub>N</sub>）}}，而中子的磁矩則為μ<sub>n</sub> = {{val|-1.91|u=μ<sub>N</sub>}}。這些參數在核磁共振成像中也是十分重要的。

===穩定性===

單獨存在的中子是不穩定的：它會進行[[β衰變]]（其中一種[[放射性衰變]]），變為質子、電子和一個[[電中微子]]，[[半衰期]]約為10分鐘（見[[中子]]）。質子單獨存在時是基本穩定的，或者其衰變率過於慢，無法探測得出。（這是粒子物理學中重要的課題，見[[質子衰變]]。）

在一個原子核裏，根據不同的[[核素]]，質子和中子可以是穩定或不穩定的。在某些核素裏，中子能夠轉變為質子（加上其他粒子）；在另一些核素裏，發生的卻可以是相反的，質子會通過β+衰變或[[電子捕獲]]變為中子（加上其他粒子）；最後，某些核素中的質子和中子均為穩定的，不會進行轉變。

===反核子===

{{main|反中子|反質子|反物質}}

兩種核子都有其對應的[[反粒子]]：[[反質子]]和[[反中子]]。這些[[反物質]]粒子的質量和其正粒子的相同，但電荷正負相反，它們的相互作用與正粒子之間的無異。（一般這是「完全」正確的，這是由於[[CPT對稱]]。如果確實存在差異，則差異必定太小，以致實驗至今仍未能探測得出。）而且，反核子能夠結合形成「反原子核」。到目前為止，科學家已經創造了[[氘#反氘|反氘]]<ref>{{cite journal|author = Massam, T|year = 1965 |title = Experimental observation of antideuteron production |journal = Il Nuovo Cimento |volume = 39|pages = 10–14 |doi = 10.1007/BF02814251|last2 = Muller|first2 = Th.|last3 = Righini|first3 = B.|last4 = Schneegans|first4 = M.|last5 = Zichichi|first5 = A.|bibcode = 1965NCimS..39...10M }}</ref><ref>{{cite journal|author = Dorfan, D. E|year = 1965|month = June|title = Observation of Antideuterons|journal = Phys. Rev. Lett.|volume = 14|issue = 24 |pages = 1003–1006| doi = 10.1103/PhysRevLett.14.1003|last2 = Eades|first2 = J.|last3 = Lederman|first3 = L. M.|last4 = Lee|first4 = W.|last5 = Ting|first5 = C. C.|bibcode=1965PhRvL..14.1003D}}</ref>以及反氚<ref>

{{cite journal

|author=R. Arsenescu ''et al.''

|year=2003

|title=Antihelium-3 production in lead-lead collisions at 158 ''A'' GeV/''c''

|journal=[[New Journal of Physics]]

|volume=5 |pages=1

|doi=10.1088/1367-2630/5/1/301

|bibcode = 2003NJPh....5....1A }}</ref>原子核。

==詳細屬性表==

===核子===

{| class="wikitable sortable" style="text-align: center;" width=100%

|+ 核子（''[[同位旋|I]] = {{frac|1|2}}，[[奇異數|S]] = [[魅数|C]] = [[底数|B]] = 0'')

|-

! 粒子名

! class="unsortable" | 符號

! class="unsortable" | 含夸克

! [[不變質量]]（[[電子伏特|MeV]]/[[光速|c]]<sup>2</sup>）

! 不變質量（[[原子質量單位|u]])<sup>{{ref|nucleonmass|[a]}}</sup>

! ''[[同位旋|I]]<sub>3</sub>''

! ''[[總角動量量子數|J]]''<sup>''[[宇稱|P]]''</sup>

! ''[[電荷|Q]]''（[[基本電荷|e]]）

! [[磁矩]]

! [[指数衰减#平均寿命|平均寿命]]（[[秒|s]]）

! class="unsortable" | 一般衰變為

|-

| align="left" | [[質子]]<ref name=PDGProton group="PDG">[http://pdg.lbl.gov/2010/listings/rpp2010-list-p.pdf Particle listings – {{SubatomicParticle|Proton}}]</ref>

| {{SubatomicParticle|Proton}} / {{SubatomicParticle|Proton+}} / {{SubatomicParticle|Nucleon+}}

| {{SubatomicParticle|link=yes|Up quark}}{{SubatomicParticle|Up quark}}{{SubatomicParticle|link=yes|Down quark}}

| {{sort|0938.272013|{{val|938.272013|0.000023}}}}

| {{sort|1.00727646688|{{val|1.00727646677|0.00000000010}}}}

| {{sort|0.5|+{{frac|1|2}}}}

| {{sort|0.5|{{frac|1|2}}}}<sup>+</sup>

| {{sort|1|+1}}

| {{sort|2.7|{{val|2.792847356|0.000000023}}}}

| {{sort|+10|穩定}}<sup>{{ref|protonlifetime|[b]}}</sup>

| 尚未觀察到

|-

| align="left" | [[中子]]<ref name=PDGNeutron group="PDG">[http://pdg.lbl.gov/2010/listings/rpp2010-list-n.pdf Particle listings – {{SubatomicParticle|Neutron}}]</ref>

| {{SubatomicParticle|Neutron}} / {{SubatomicParticle|Neutron0}} / {{SubatomicParticle|Nucleon0}}

| {{SubatomicParticle|Up quark}}{{SubatomicParticle|Down quark}}{{SubatomicParticle|Down quark}}

| {{sort|0939.565346|{{val|939.565346|0.000023}}}}

| {{sort|1.00866491560|{{val|1.00866491597|0.00000000043}}}}

| {{sort|-0.5|-{{frac|1|2}}}}

| {{sort|0.5|{{frac|1|2}}}}<sup>+</sup>

| {{val|0}}

| {{sort|-1.9|{{val|-1.91304273|0.00000045}}}}

| {{sort|+2|{{val|8.857|0.008|e=+2}}}}<sup>{{ref|neutronlifetime|[c]}}</sup>

| {{nowrap|{{SubatomicParticle|link=yes|Proton}} + {{SubatomicParticle|link=yes|Electron}} + {{SubatomicParticle|link=yes|Electron antineutrino}}}}

|-

| align="left" | [[反質子]]

| {{SubatomicParticle|Antiproton}} / {{PhysicsParticle|p|TR=−}} / {{PhysicsParticle|N|TR=−}}

| {{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Down antiquark}}

| {{sort|0938.272013|{{val|938.272013|0.000023}}}}

| {{sort|1.00727646688|{{val|1.00727646677|0.00000000010}}}}

| {{sort|-0.5|-{{frac|1|2}}}}

| {{sort|0.5|{{frac|1|2}}}}<sup>+</sup>

| {{sort|-1|−1}}

| {{sort|-2.7|{{val|-2.793|0.006}}}}

| {{sort|+10|穩定}}<sup>{{ref|protonlifetime|[b]}}</sup>

| 尚未觀察到

|-

| align="left" | [[反中子]]

| {{SubatomicParticle|Antineutron}} / {{SubatomicParticle|Antineutron0}} / {{SubatomicParticle|Antinucleon0}}

| {{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Down antiquark}}{{SubatomicParticle|Down antiquark}}

| {{sort|0939.565346|{{val|939.485|0.051}}}}

| {{sort|1.00866491560|{{val|1.00866491597|0.00000000043}}}}

| {{sort|0.5|+{{frac|1|2}}}}

| {{sort|0.5|{{frac|1|2}}}}<sup>+</sup>

| {{val|0}}

| ?

| {{sort|+2|{{val|8.857|0.008|e=+2}}}}<sup>{{ref|neutronlifetime|[c]}}</sup>

| {{nowrap|{{SubatomicParticle|link=yes|Antiproton}} + {{SubatomicParticle|link=yes|Positron}} + {{SubatomicParticle|link=yes|Electron neutrino}}}}

|}

{{note|nucleonmass|a}}質子和中子質量的準確度在用[[原子質量單位]]（u）

時比用MeV/c<sup>2</sup>時準確得多，因為[[基本電荷]]的準確度相對較低。此處用的對換關係為1 u = {{val|931.494028|0.000023}} MeV/c<sup>2</sup>。

正反粒子的質量是假設相同的，至今沒有實驗能夠駁斥這一點。目前的實驗顯示，如果正反質子之間有質量上的差異的話，其出入小於{{val|2|e=-9}} MeV/c<sup>2</sup>，<ref name=PDGProton group="PDG"/>而正反中子的質量差異則小於{{val|9|6|e=-5}} MeV/c<sup>2</sup>。<ref name=PDGNeutron group="PDG"/>

{| class="wikitable"

|+ 正反質子CPT不變性試驗

|-

! 試驗

! 公式

! 結果<ref name=PDGProton group="PDG"/>

|-

| [[質量]]

|<math>\frac{|m\_p-m\_\bar{p}|}{m\_p}</math>

|< {{val|2|e=-9}}

|-

| [[質荷比]]

|<math>\frac{|\frac{q\_\bar{p}}{m\_\bar{p}}|}{(\frac{q\_p}{m\_p})}</math>

|{{val|0.99999999991|0.00000000009}}

|-

| 質荷比偏差率

|<math>\frac{|\frac{q\_\bar{p}}{m\_\bar{p}}| - \frac{q\_p}{m\_p}}{\frac{q\_p}{m\_p}}</math>

|{{val|-9|9|e=-11}}

|-

| 電荷

|<math>\frac{|q\_p+q\_\bar{p}|}{e}</math>

|< {{val|2|e=-9}}

|-

| 電子電荷

|<math>\frac{|q\_p+q\_e|}{e}</math>

|<{{val|1|e=-21}}

|-

| 磁矩

|<math>\frac{|\mu\_p+\mu\_\bar{p}|}{\mu\_p}</math>

|{{val|-0.1|2.1|e=-3}}

|}

{{note|protonlifetime|b}}至少10<sup>35</sup>年。見[[質子衰變]]。

{{note|neutronlifetime|c}}假設為自由中子；多數原子核中的中子都是穩定的。<br>

</small>

===核子共振===

'''核子共振態'''指的是核子的[[激發態]]，一般對應於核子中某個夸克擁有反轉了的《自旋》態，或對應於該粒子衰變時的[[角量子數|軌道角動量]]。下表只列出《粒子數據組》（PDG）評級為3或4星的共振態。由於半衰期極短，以下許多粒子的屬性仍在研究當中。

符號的格式為N(M) L<sub>2I2J</sub>，其中M為粒子質量的近似值，L為核子-介子對衰變時產生的軌道角動量，而I和J分別為粒子的《同位旋》及《總角動量量子數|總角動量》。由於核子的同位旋被定義為{{frac|1|2}}，因此第一個數字必然為1，而第二個數字則永遠是奇數。在談到核子共振態的時候，有時會省略N，而且表達式順序會顛倒：L<sub>2I2J</sub> (M)。例如，質子的符號可以寫成"N(939) S<sub>11</sub>"或者"S<sub>11</sub> (939)"。

下表只列出基共振態，每一欄代表4個《重子》：2個核子共振粒子，和2個它們的反粒子。每個共振態的存在形態可以是帶正《電荷》（Q）的，並含夸克{{SubatomicParticle|Up quark}}{{SubatomicParticle|Up quark}}{{SubatomicParticle|Down quark}}，就像質子一樣；或者是電中性的，含夸克{{SubatomicParticle|Up quark}}{{SubatomicParticle|Down quark}}{{SubatomicParticle|Down quark}}，就像中子一樣；又或者是兩種反粒子，分別含反夸克{{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Down antiquark}}和{{SubatomicParticle|Up antiquark}}{{SubatomicParticle|Down antiquark}}{{SubatomicParticle|Down antiquark}}。由於不含有《奇夸克》、《粲夸克》、《底夸克》和《頂夸克》，這些粒子不具備《奇異數》、[[魅数]]、[[底数]]及[[頂數]]。下表只列出同位旋為{{frac|1|2}}的共振態，具{{frac|3|2}}同位旋的共振態請參看《Δ粒子》條目。

{| class="wikitable sortable" style="text-align: center;" width=100%

|+ 核子共振態（[[同位旋|I]] = {{frac|1|2}}）

|-

! 符號

! ''[[總角動量量子數|J]]''<sup>''[[宇稱|P]]''</sup>

! [[不變質量|質量]]平均數<br />（[[電子伏特|MeV]]/[[光速|c]]<sup>2</sup>)

! [[相對論性布萊特-維格納分佈|總寬度]]<br />（MeV/c<sup>2</sup>）

! 極位置<br />（實數部分）

! 極位置<br />（−2 × 虛數部分）

! class=unsortable|通常衰變為<br />（Γ<sub>i</sub> /Γ > 50%）

|- style="height:40px"

| N(939) P<sub>11</sub><br /><ref name="PDGN939" group="PDG">[http://pdg.lbl.gov/2011/reviews/rpp2011-rev-n-delta-resonances.pdf Particle listings — Note on N and Delta Resonances]</ref>†

| {{sort|0.5|{{frac|1|2}}}}<sup>+</sup>

| 939

| †

| †

| †

| †

|- style="height:40px"

| N(1440) P<sub>11</sub><br /><ref name="PDGN1440" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1440-P11.pdf Particle listings — N(1440)]</ref><br />亦稱[[羅佩爾共振態]]

| {{sort|0.5|{{frac|1|2}}}}<sup>+</sup>

| 1440<br />(1420–1470)

| 300<br />(200–450)

| 1365<br />(1350–1380)

| 190<br />(160–220)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}}}}

|- style="height:40px"

| N(1520) D<sub>13</sub><br /><ref name="PDGN1520" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1520-D13.pdf Particle listings — N(1520)]</ref>

| {{sort|1.5|{{frac|3|2}}}}<sup>-</sup>

| 1520<br />(1515–1525)

| 115<br />(100–125)

| 1510<br />(1505–1515)

| 110<br />(105–120)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}}}}

|- style="height:40px"

| N(1535) S<sub>11</sub><br /><ref name="PDGN1535" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1535-S11.pdf Particle listings — N(1535)]</ref>

| {{sort|0.5|{{frac|1|2}}}}<sup>-</sup>

| 1535<br />(1525–1545)

| 150<br />(125–175)

| 1510<br />1490 — 1530)

| 170<br />(90–250)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} or}}<br />

{{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Eta}}}}

|- style="height:40px"

| N(1650) S<sub>11</sub><br /><ref name="PDGN1650" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1650-S11.pdf Particle listings — N(1650)]</ref>

| {{sort|0.5|{{frac|1|2}}}}<sup>-</sup>

| 1650<br />(1645–1670)

| 165<br />(145–185)

| 1665<br />(1640–1670)

| 165<br />(150–180)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}}}}

|- style="height:40px"

| N(1675) D<sub>15</sub><br /><ref name="PDGN1675" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1675-D15.pdf Particle listings — N(1675)]</ref>

| {{sort|2.5|{{frac|5|2}}}}<sup>-</sup>

| 1675<br />(1670–1680)

| 150<br />(135–165)

| 1660<br />(1655–1665)

| 135<br />(125–150)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} + {{SubatomicParticle|link=yes|Pion}} or}}<br />

{{nowrap|{{SubatomicParticle|link=yes|Delta}} + {{SubatomicParticle|link=yes|Pion}}}}

|- style="height:40px"

| N(1680) F<sub>15</sub><br /><ref name="PDGN1680" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1680-F15.pdf Particle listings — N(1680)]</ref>

| {{sort|2.5|{{frac|5|2}}}}<sup>+</sup>

| 1685<br />(1680–1690)

| 130<br />(120–140)

| 1675<br />(1665–1680)

| 120<br />(110–135)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}}}}

|- style="height:40px"

| N(1700) D<sub>13</sub><br /><ref name="PDGN1700" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1700-D13.pdf Particle listings — N(1700)]</ref>

| {{sort|1.5|{{frac|3|2}}}}<sup>-</sup>

| 1700<br />(1650–1750)

| 100<br />(50–150)

| 1680<br />(1630–1730)

| 100<br />(50–150)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} + {{SubatomicParticle|link=yes|Pion}}}}

|- style="height:40px"

| N(1710) P<sub>11</sub><br /><ref name="PDGN1710" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1710-P11.pdf Particle listings — N(1710)]</ref>

| {{sort|0.5|{{frac|1|2}}}}<sup>+</sup>

| 1710<br />(1680–1740)

| 100<br />(50–250)

| 1720<br />(1670–1770)

| 230<br />(80–380)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} + {{SubatomicParticle|link=yes|Pion}}}}

|- style="height:40px"

| N(1720) P<sub>13</sub><br /><ref name="PDGN1720" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-1720-P13.pdf Particle listings — N(1720)]</ref>

| {{sort|1.5|{{frac|3|2}}}}<sup>+</sup>

| 1720<br />(1700–1750)

| 200<br />(150–300)

| 1675<br />(1660–1690)

| 115–275

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} + {{SubatomicParticle|link=yes|Pion}} or}}<br />

{{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Rho}}}}

|- style="height:40px"

| N(2190) G<sub>17</sub><br /><ref name="PDGN2190" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-2190-G17.pdf Particle listings — N(2190)]</ref>

| {{sort|3.5|{{frac|7|2}}}}<sup>-</sup>

| 2190<br />(2100–2200)

| 500<br />(300–700)

| 2075<br />(2050–2100)

| 450<br />(400–520)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} (10—20%)}}

<!-- \*\* http://pdg.lbl.gov/2011/listings/rpp2011-list-N-2200-D15.pdf -->

|- style="height:40px"

| N(2220) H<sub>19</sub><br /><ref name="PDGN2220" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-2220-H19.pdf Particle listings — N(2220)]</ref>

| {{sort|4.5|{{frac|9|2}}}}<sup>+</sup>

| 2250<br />(2200–2300)

| 400<br />(350–500)

| 2170<br />(2130–2200)

| 480<br />(400–560)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} (10—20%)}}

|- style="height:40px"

| N(2250) G<sub>19</sub><br /><ref name="PDGN2250" group="PDG">[http://pdg.lbl.gov/2011/listings/rpp2011-list-N-2250-G19.pdf Particle listings — N(2250)]</ref>

| {{sort|4.5|{{frac|9|2}}}}<sup>-</sup>

| 2250<br />(2200–2350)

| 500<br />(230–800)

| 2200<br />(2150–2250)

| 450<br />(350–550)

| {{nowrap|{{SubatomicParticle|link=yes|Nucleon}} + {{SubatomicParticle|link=yes|Pion}} (5—15%)}}

|}

† P<sub>11</sub>(939)核子是普通質子或中子的激發態，如位於原子核裏的核子。這些粒子在原子核裏基本穩定，如[[鋰]]-6。

==夸克模型分類==

在具有[[SU(2)]][[味 (粒子物理学)|味]]的夸克模型裏，兩種核子是一個基態二重態的一部分。質子的夸克組成為''uud''，而中子的則為''udd''。在具有[[SU(3)]]味的模型中，它們是《自旋》為{{frac|1|2}}《重子》形成的基態八重態的一部分，物理中稱之為《八重道》。此八重態的其他部分包括《超子》《奇異數|奇》三重態[[Σ粒子|{{SubatomicParticle|Sigma+}}, {{SubatomicParticle|Sigma0}}, {{SubatomicParticle|Sigma-}}]]、[[Λ粒子|{{SubatomicParticle|Lambda}}]]以及奇同位二重態[[Ξ粒子|{{SubatomicParticle|Xi0}}, {{SubatomicParticle|Xi-}}]]。我們還可以將其延伸到[[SU(4)]]味（包括粲夸克）基態20重態，或[[SU(6)]]味（包括頂和底夸克）基態56重態。

==Models==<!-- This section is linked from [[Casimir effect]] -->

{{Confusing|date=August 2007}}

Although it is known that the nucleon is made from three quarks, {{As of|2006|lc=on}}, it is not known how to solve the [[equations of motion]] for [[quantum chromodynamics]]. Thus, the study of the low-energy properties of the nucleon are performed by means of models. The only first-principles approach available is to attempt to solve the equations of QCD numerically, using [[lattice QCD]]. This requires complicated algorithms and very powerful [[supercomputer]]s. However, several analytic models also exist:

The [[Skyrmion]] models the nucleon as a [[topological soliton]] in a non-linear [[SU(2)]] [[pion]] field. The topological stability of the Skyrmion is interpreted as the conservation of [[baryon number]], that is, the non-decay of the nucleon. The local [[topological winding number]] density is identified with the local [[baryon number]] density of the nucleon. With the pion isospin vector field oriented in the shape of a [[hedgehog space]], the model is readily solvable, and is thus sometimes called the '''hedgehog model'''. The hedgehog model is able to predict low-energy parameters, such as the nucleon mass, radius and [[axial coupling constant]], to approximately 30% of experimental values.

The [[MIT bag model]] confines three non-interacting quarks to a spherical cavity, with the [[boundary condition]] that the quark [[vector current]] vanish on the boundary. The non-interacting treatment of the quarks is justified by appealing to the idea of [[asymptotic freedom]], whereas the hard boundary condition is justified by [[quark confinement]]. Mathematically, the model vaguely resembles that of a [[radar cavity]], with solutions to the [[Dirac equation]] standing in for solutions to the [[Maxwell equations]] and the vanishing vector current boundary condition standing for the conducting metal walls of the radar cavity. If the radius of the bag is set to the radius of the nucleon, the bag model predicts a nucleon mass that is within 30% of the actual mass. An important failure of the basic bag model is its failure to provide a pion-mediated interaction.

The '''chiral bag model'''<ref>{{cite journal|author = [[Gerald E. Brown]] and [[Mannque Rho]]|year = 1979|month = March|title = The little bag|journal = Phys. Lett. B|volume = 82|issue = 2 |pages = 177–180| doi = 10.1016/0370-2693(79)90729-9|bibcode = 1979PhLB...82..177B }}</ref> merges the MIT bag model and the Skyrmion model. In this model, a hole is punched out of the middle of the Skyrmion, and replaced with a bag model. The boundary condition is provided by the requirement of continuity of the [[axial vector current]] across the bag boundary. Very curiously, the missing part of the topological winding number (the baryon number) of the hole punched into the Skyrmion is exactly made up by the non-zero [[vacuum expectation value]] (or [[spectral asymmetry]]) of the quark fields inside the bag. {{As of|2006}}, this remarkable trade-off between [[topology]] and the [[spectrum of an operator]] does not have any grounding or explanation in the mathematical theory of [[Hilbert space]]s and their relationship to [[geometry]]. Several other properties of the chiral bag are notable: it provides a better fit to the low energy nucleon properties, to within 5–10%, and these are almost completely independent of the chiral bag radius (as long as the radius is less than the nucleon radius). This independence of radius is referred to as the '''Cheshire Cat principle''', after the fading to a smile of [[Lewis Carroll]]'s [[Cheshire Cat]]. It is expected that a first-principles solution of the equations of QCD will demonstrate a similar duality of quark-pion descriptions.

==參見==

\* [[重子]]

\* [[電弱交互作用]]

==延伸閱讀==

\* A.W. Thomas and W.Weise, ''The Structure of the Nucleon'', (2001) Wiley-WCH, Berlin, ISBN [http://www.wiley-vch.de/publish/en/books/bySubjectPH00/ISBN3-527-40297-7/ ISBN 3-527-40297-7]

\*YAN Kun. [http://inspirebeta.net/record/913262 Equation of average binding energy per nucleon]. {{doi|10.3969/j.issn.1004-2903.2011.01.018}}

\* {{cite book

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|last2=Jackson |first2=A. D.

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|isbn=0-7204-0335-9

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|last2=Jackson |first2=A.D.

|last3=Goldhaber |first3=A.S.

|year=1984

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|volume=140 |issue= 5–6|pages=280–284

|arxiv=

|bibcode=1984PhLB..140..280V

|doi=10.1016/0370-2693(84)90753-6

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\*{{cite journal

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|last2=Jackson |first2=A. D.

|year=1990

|title=Justifying the chiral bag

|journal=[[Physics Reports]]

|volume=187 |issue=3 |pages=109–143

|bibcode=1990PhR...187..109V

|doi=10.1016/0370-1573(90)90056-8

}}

\* {{cite journal

|last=Nakamura |first=N.

|year=2011

|coauthors=''et al.'' ([[Particle Data Group]])

|journal=[[Journal of Physics G]]

|volume=37 |issue=7 |pages=075021

|doi=10.1088/0954-3899/37/7A/075021

|title=Review of Particle Physics

|bibcode = 2010JPhG...37g5021N }}

==參考資料==

{{reflist}}

===粒子列表===

{{reflist|2|liststyle=decimal-leading-zero|group=PDG}}

{{particles}}

[[Category:Hadrons]]

[[Category:Baryons]]

[[Category:Neutron]]

[[Category:Nucleons| ]]

[[af:Nukleon]]

[[ar:نوكليون]]

[[bg:Нуклеон]]

[[bs:Nukleon]]

[[br:Nukleon]]

[[ca:Nucleó]]

[[cv:Нуклон]]

[[cs:Nukleon]]

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[[de:Nukleon]]

[[et:Nukleonid]]

[[es:Nucleón]]

[[eo:Nukleono]]

[[eu:Nukleoi]]

[[fa:ذرات هسته‌ای]]

[[fr:Nucléon]]

[[ga:Núicléón]]

[[gl:Nucleón]]

[[ko:핵자]]

[[hr:Nukleon]]

[[io:Nukleo]]

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[[lmo:Nücleun]]

[[hu:Nukleon]]

[[nl:Nucleon]]

[[ja:核子]]

[[no:Nukleon]]

[[nn:Nukleon]]

[[pnb:نیوکلیون]]

[[nds:Nukleon]]

[[pl:Nukleony]]

[[pt:Nucleon]]

[[ru:Нуклон]]

[[si:නියුක්ලියෝන]]

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[[sr:Nukleon]]

[[fi:Nukleoni]]

[[sv:Nukleon]]

[[ta:அணுக்கருனி]]

[[th:นิวคลีออน]]

[[tr:Nükleon]]

[[uk:Нуклон]]

[[ur:نوینہ]]

[[vec:Nucleon]]

[[fiu-vro:Nukleon]]