SI Unit Relations

Images created for "What are the proposed realizations in the New SI for the kilogram, ampere, kelvin and mole?" at http://physics.stackexchange.com/q/147433, and "Redefinition of SI base units" at https://en.wikipedia.org/wiki/Redefinition_of_SI_base_units.

MaTeX for the $\Delta\nu_{Cs}$ handling

The $\Delta\nu_{Cs}$ symbol in the figures below is produced using

In[5]:= `MaTeX["\\Delta\\nu", "Preamble" → {"\\usepackage{pxfonts}"}, Magnification → 3]`

Out[5]= $\Delta\nu$

This requires the MaTeX package, which can be installed from https://github.com/szhorvat/MaTeX, as well as the pxfonts package to be accessible to xelatex.

In[1]:= `<< MaTeX``

Moreover, this requires MaTeX to run on the xelatex compiler. That can be ensured by running ConfigureMaTeX on the commands

In[2]:= `ConfigureMaTeX[`
  `"pdfLaTeX" → "C:\\Program Files\\MiKTeX 2.9\\miktex\\bin\\x64\\xelatex.exe"]`

Out[2]= {Ghostscript → C:\Program Files\gs\gs9.19\bin\gswin64c.exe, CacheSize → 100,
  pdfLaTeX → C:\Program Files\MiKTeX 2.9\miktex\bin\x64\xelatex.exe}

over Windows, or as ConfigureMaTeX["pdfLaTeX"→"/Library/TeX/texbin/pdflatex"] over linux.

However, it's important to note that this will "pollute" your MaTeX installation, and it will continue to compile using xelatex until you tell it otherwise. That can be ensured using the command below.

In[4]:= `MaTeX`Developer`ResetConfiguration[]`

Colors

```
In[6]:=  siColorkg = RGBColor[{207, 18, 45} / 255];
         siColorm = RGBColor[{236, 103, 40} / 255];
         siColors = RGBColor[{248, 169, 9} / 255];
         siColorA = RGBColor[{98, 168, 48} / 255];
         siColorK = RGBColor[{25, 93, 169} / 255];
         siColormol = RGBColor[{171, 55, 140} / 255];
         siColorcd = RGBColor[{65, 40, 132} / 255];

         siColorh = RGBColor[{231, 137, 150} / 255];
         siColorc = RGBColor[{246, 179, 147} / 255];
         siColorΔν = RGBColor[{251, 212, 132} / 255];
         siColore = RGBColor[{176, 212, 152} / 255];
         siColorkB = RGBColor[{140, 174, 212} / 255];
         siColorNA = RGBColor[{213, 155, 198} / 255];
         siColorKcd = RGBColor[{160, 147, 194} / 255];
```

Old SI figure

```
In[184]:=  fs = 28;
           fs2 = 26;
           φ = 2 π / 7;
           p[n_] := 4.5 {Sin[n φ], Cos[n φ]}
           q[n_] := 8 {Sin[n φ], Cos[n φ]}
           oldSI = Show[{
              Graphics[{siColors, Disk[p[0], 1]}],
              Graphics[{Text[
                 Style["s", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[0]]}],
              Graphics[{siColorkg, Disk[p[1], 1]}],
              Graphics[{Text[
                 Style["kg", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[1]]}],
              Graphics[{siColormol, Disk[p[2], 1]}],
              Graphics[{Text[Style["mol", fs,
                    GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[2]]}],
              Graphics[{siColorcd, Disk[p[3], 1]}],
              Graphics[{Text[
                 Style["cd", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[3]]}],
              Graphics[{siColorK, Disk[p[4], 1]}],
              Graphics[{Text[
                 Style["K", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[4]]}],
              Graphics[{siColorA, Disk[p[5], 1]}],
              Graphics[{Text[
                 Style["A", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[5]]}],
              Graphics[{siColorm, Disk[p[6], 1]}],
              Graphics[{Text[
                 Style["m", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[6]]}],

              Graphics[{siColorΔν, Disk[q[0], 1.1]}],
              Graphics[{Text[
                 Row[{
                    MaTeX["\\Delta\\nu",
                       "Preamble" → {"\\usepackage{pxfonts}"}, Magnification → 2],
```

```
      Style[""_"Cs", 18, FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]]
     }], q[0]]}],
  Graphics[{GrayLevel[0.6], Disk[q[1], 1]}],
  Graphics[{Text[Style["M"_"IPK", fs2 - 2,
     FontFamily → "Source Sans Pro Semibold", GrayLevel[1]], q[1]]}],
  Graphics[{GrayLevel[0.6], Disk[q[2], 1]}],
  Graphics[{Text[Style["m(¹²C)", fs2 - 9,
     FontFamily → "Source Sans Pro Semibold", Bold, GrayLevel[1]], q[2]]}],
  Graphics[{siColorKcd, Disk[q[3], 1]}],
  Graphics[{Text[Style["K"_"cd", fs2,
     FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[3]]}],
  Graphics[{GrayLevel[0.6], Disk[q[4], 1]}],
  Graphics[{Text[Style["T"_"TPW", fs2 - 2,
     FontFamily → "Source Sans Pro Semibold", GrayLevel[1]], q[4]]}],
  Graphics[{GrayLevel[0.6], Disk[q[5], 1]}],
  Graphics[{Text[Style["μ"_"0", fs2,
     FontFamily → "Source Sans Pro Semibold", GrayLevel[1]], q[5]]}],
  Graphics[{siColorc, Disk[q[6], 1]}],
  Graphics[{Text[Style["c", fs2,
     FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[6]]}],

  Graphics[{
    h = Graphics[{Thickness[0.007], Line[0.5 {{-1, 1/2}, {0, 0}, {-1, -1/2}}]}];
    Thickness[0.007], Arrowheads[{{0.05, 1, h}}], GrayLevel[0.6],
    Arrow[{p[0], p[6]}, {1.05, 1.2}],
    Arrow[{p[0], p[3]}, {1.05, 1.2}],
    Arrow[{p[0], p[5]}, {1.05, 1.2}],
    Arrow[{p[6], p[3]}, {1.05, 1.2}],
    Arrow[{p[6], p[5]}, {1.05, 1.2}],
    Arrow[{p[1], p[2]}, {1.05, 1.2}],
    Arrow[{p[1], p[3]}, {1.05, 1.2}],
    Arrow[{p[1], p[5]}, {1.05, 1.2}]
    } ~ Join ~ (
    Arrow[{q[#], p[#]}, {1.05, 1.2}] & /@ Range[0, 6]
    )],
  Graphics[Text[Style["Old SI", Bold, 30], {0, 10}]]
  }
 , ImageSize → 500
]
```

Old SI

Out[189]=
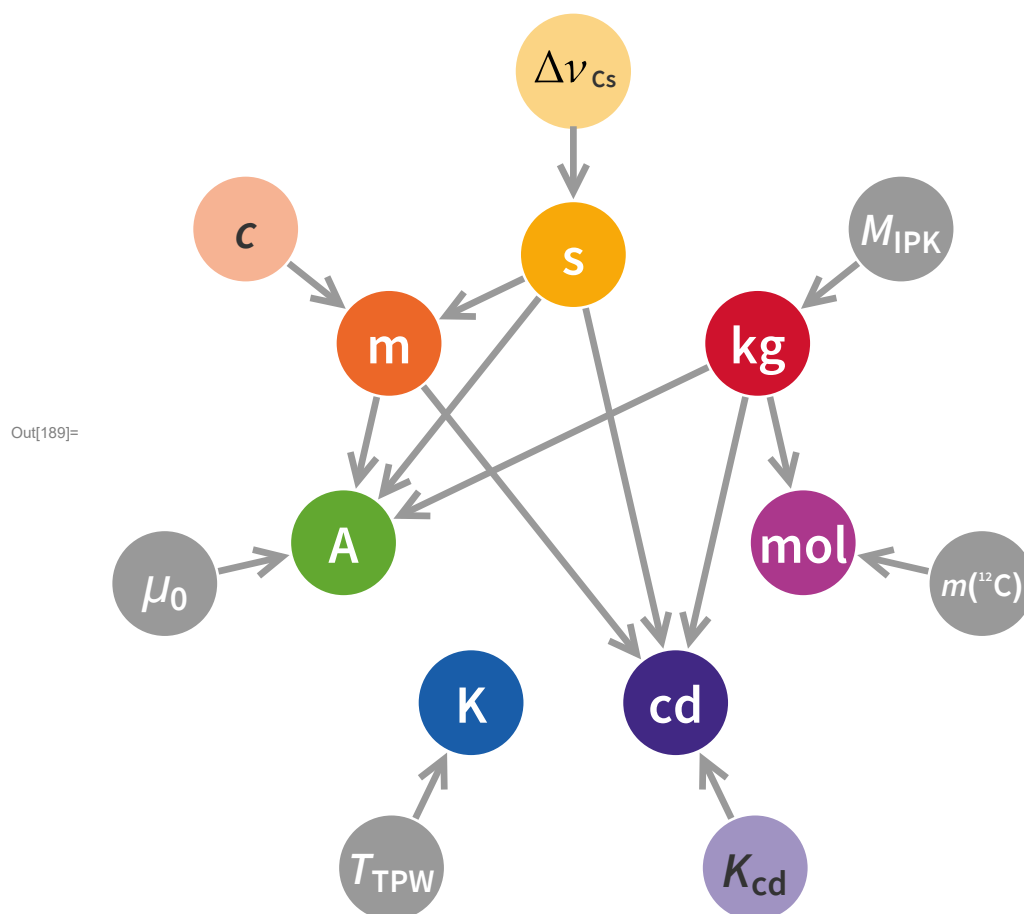
In[190]:= **FileSize[Export[**
    FileNameJoin[{NotebookDirectory[], "Unit relations in the old SI.svg"}], oldSI]]
  FileSize[Export[FileNameJoin[{NotebookDirectory[],
      "Unit relations in the old SI.png"}], oldSI]]

Out[190]= 68.082 kB

Out[191]= 36.096 kB

New SI figure

In[70]:= **fs = 28;**
  fs2 = 26;
  φ = 2 π / 7;
  p[n_] := 4.5 {Sin[n φ], Cos[n φ]}
  q[n_] := 8 {Sin[n φ], Cos[n φ]}
  newSI = Show[{
    Graphics[{siColors, Disk[p[0], 1]}],
    Graphics[{Text[
      Style["s", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[0]]}],
    Graphics[{siColorkg, Disk[p[1], 1]}],
    Graphics[{Text[
      Style["kg", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[1]]}],
    Graphics[{siColormol, Disk[p[2], 1]}],

```mathematica
Graphics[{Text[Style["mol", fs,
    GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[2]]}],
Graphics[{siColorcd, Disk[p[3], 1]}],
Graphics[{Text[
   Style["cd", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[3]]}],
Graphics[{siColorK, Disk[p[4], 1]}],
Graphics[{Text[
   Style["K", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[4]]}],
Graphics[{siColorA, Disk[p[5], 1]}],
Graphics[{Text[
   Style["A", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[5]]}],
Graphics[{siColorm, Disk[p[6], 1]}],
Graphics[{Text[
   Style["m", fs, GrayLevel[1], FontFamily → "Source Sans Pro Semibold"], p[6]]}],

Graphics[{siColorΔν, Disk[q[0], 1.1]}],
Graphics[{Text[
   Row[{
     MaTeX["\\Delta\\nu",
       "Preamble" → {"\\usepackage{pxfonts}"}, Magnification → 2],
     Style[""_"Cs", 18, FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]]
    }], q[0]]}],
Graphics[{siColorh, Disk[q[1], 1]}],
Graphics[{Text[Style["h", fs2,
   FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[1]]}],
Graphics[{siColorNA, Disk[q[2], 1]}],
Graphics[{Text[Style["N"_"A", fs2,
   FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[2]]}],
Graphics[{siColorKcd, Disk[q[3], 1]}],
Graphics[{Text[Style["K"_"cd", fs2,
   FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[3]]}],
Graphics[{siColorkB, Disk[q[4], 1]}],
Graphics[{Text[Style["k"_"B", fs2,
   FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[4]]}],
Graphics[{siColore, Disk[q[5], 1]}],
Graphics[{Text[Style["e", fs2,
   FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[5]]}],
Graphics[{siColorc, Disk[q[6], 1]}],
Graphics[{Text[Style["c", fs2,
   FontFamily → "Source Sans Pro Semibold", GrayLevel[0.2]], q[6]]}],

Graphics[{
  h = Graphics[{Thickness[0.007], Line[0.5 {{-1, 1/2}, {0, 0}, {-1, -1/2}}]}];
  Thickness[0.007], Arrowheads[{{0.05, 1, h}}], GrayLevel[0.6],
  Arrow[{p[0], p[1]}, {1.05, 1.2}],
  Arrow[{p[0], p[3]}, {1.05, 1.2}],
  Arrow[{p[0], p[4]}, {1.05, 1.2}],
  Arrow[{p[0], p[5]}, {1.05, 1.2}],
  Arrow[{p[0], p[6]}, {1.05, 1.2}],
  Arrow[{p[1], p[3]}, {1.05, 1.2}],
  Arrow[{p[1], p[4]}, {1.05, 1.2}],
  Arrow[{p[6], p[1]}, {1.05, 1.2}],
  Arrow[{p[6], p[3]}, {1.05, 1.2}],
  Arrow[{p[6], p[4]}, {1.05, 1.2}]
  } ~ Join ~ (
```
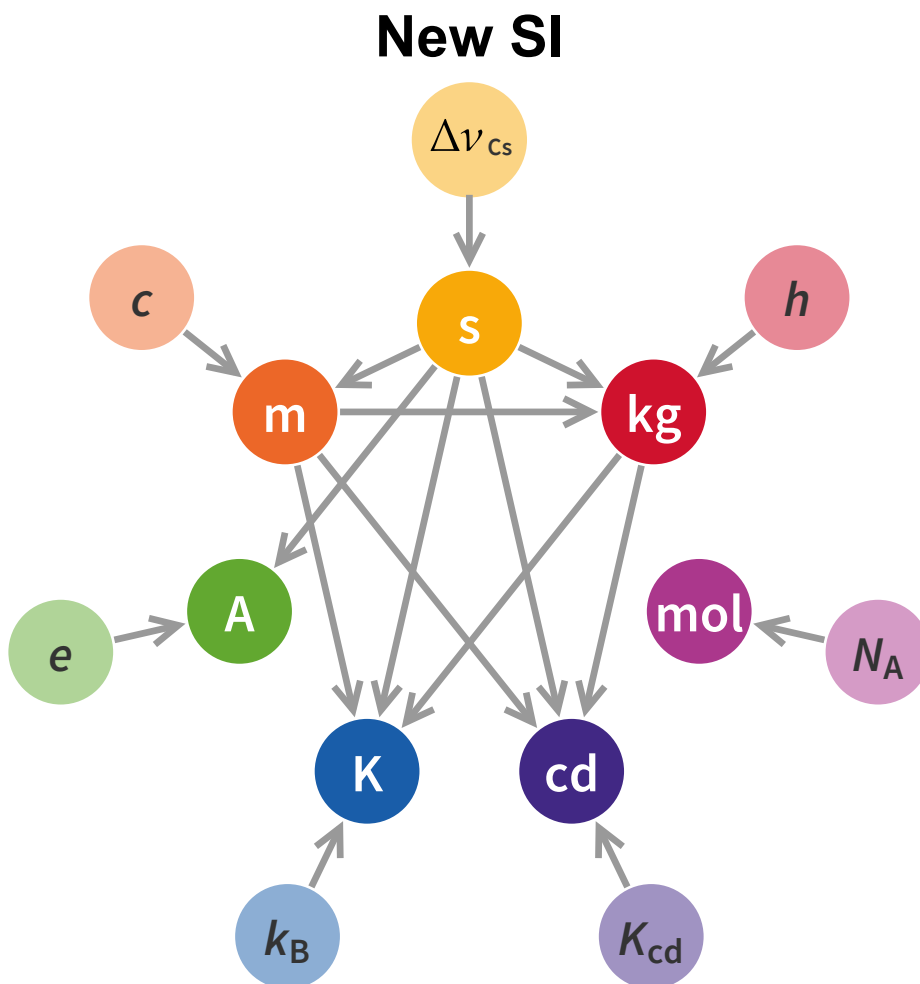
```
      Arrow[{q[#], p[#]}, {1.05, 1.2}] & /@ Range[0, 6]
      )],
    Graphics[Text[Style["New SI", Bold, 30], {0, 10}]]
  }
  , ImageSize → 500
]
```

New SI

Out[75]=


```
In[68]:= FileSize[Export[
        FileNameJoin[{NotebookDirectory[], "Unit relations in the new SI.svg"}], newSI]]
      FileSize[Export[FileNameJoin[{NotebookDirectory[],
          "Unit relations in the new SI.png"}], newSI]]
```

Out[68]= 56.283 kB

Out[69]= 38.244 kB