In [1]:
```
ENV["PYTHON"] = ""
```

Out[1]: ""

Análisis del Catálogo de LASCO para CMEs

Introducción

El propósito principal de este análisis es, además de el de ver qué fracción de los datos de CMEs son tipo "Halo", cuantos de estos eventos ocurren por año, y cuál es la distribución de velocidades de estos eventos.

El catálogo se puede encontrar en la liga https://cdaw.gsfc.nasa.gov/CME_list/ (https://cdaw.gsfc.nasa.gov/CME_list/) en la que se pueden ver todos los datos en detalle. Una descripción completa del catálogo puede encontrarse en la liga: https://cdaw.gsfc.nasa.gov/CME_list/catalog_description.htm (https://cdaw.gsfc.nasa.gov/CME_list/catalog_description.htm) por N. Gopalswamy, 2005 September 30, que contiene una lista de referencias, que se encuentran al final de esta libreta.

En las dos últimas columnas del catálogo se enuentran imágenes del medio interplanetario en presencia de las eyecciones, así como gráficas de datos del medio interplanetario de que provienen de otras fuentes, y una película java.

Metodología

La versión de texto de los datos, que es la que vamos a utilizar se encuentra en la página: https://cdaw.gsfc.nasa.gov/CME_list/UNIVERSAL/text_ver/ (https://cdaw.gsfc.nasa.gov/CME_list/UNIVERSAL/text_ver/), la cual es necesario editar para quedarnos solamente con los datos. El archivo se llama univ_all.txt, el cual hay que bajar y poner en el directorio de la libreta.

In [2]:
```
A = readdlm("univ_all_NA.txt") # Lectura de los datos
```

Out[2]:
```
26585x30 Array{Any,2}:
 "=========="   "SOHO/LASCO"  …  ""  ""  ""  ""  ""  ""  ""  ""  ""
 "Date"         "Time"           ""  ""  ""  ""  ""  ""  ""  ""  ""
 "PA"           "Speed"          ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/01/11"   "00:14:36"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/01/13"   "22:08:30"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/01/15"   "07:01:10"    …  ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/01/22"   "03:11:01"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/01/26"   "09:16:19"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/01/31"   "06:52:13"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/02/03"   "00:07:03"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/02/08"   "05:17:49"    …  ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/02/12"   "05:47:26"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "1996/02/17"   "02:06:31"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 ⋮                              ⋱                   ⋮
 "2015/10/30"   "11:00:04"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/30"   "15:14:23"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/30"   "17:00:05"    …  ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/30"   "19:00:04"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "01:48:04"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "03:36:04"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "08:48:04"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "09:12:09"    …  ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "17:36:05"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "18:36:04"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "19:36:04"       ""  ""  ""  ""  ""  ""  ""  ""  ""
 "2015/10/31"   "23:12:09"       ""  ""  ""  ""  ""  ""  ""  ""  ""
```

Para quedarnos solamente con los datos propiamente dichos, es decir, sin encabezados ni comentarios, creamos la matriz B

In [4]:
```
B = [A[2,1:12]; A[4:end,1:12]]
```

Out[4]:
```
26583x12 Array{Any,2}:
 "Date"         "Time"       …   "Mass"       "Kinetic"      "MPA"
 "1996/01/11"   "00:14:36"       "NA"         "NA"          272
 "1996/01/13"   "22:08:30"       "NA"         "NA"          266
 "1996/01/15"   "07:01:10"       "NA"         "NA"          272
 "1996/01/22"   "03:11:01"       "7.1e+13*"   "2.5e+28*"    103
 "1996/01/26"   "09:16:19"   …   3.0e14       1.0e29         90
 "1996/01/31"   "06:52:13"       "2.5e+14*"   "3.2e+28*"    272
 "1996/02/03"   "00:07:03"       1.9e15       8.9e29         80
 "1996/02/08"   "05:17:49"       1.6e14       2.7e28        249
 "1996/02/12"   "05:47:26"       1.3e15       1.6e29         92
 "1996/02/17"   "02:06:31"   …   "3.3e+14*"   "1.6e+29*"    274
 "1996/02/17"   "05:18:59"       "2.1e+14*"   "3.1e+28*"     88
 "1996/02/19"   "05:15:48"       "1.3e+14*"   "4.6e+28*"     94
 ⋮                              ⋱            ⋮
 "2015/10/30"   "11:00:04"       "NA"         "NA"          269
 "2015/10/30"   "15:14:23"       1.1e14       1.4e29        269
 "2015/10/30"   "17:00:05"       "2.0e+15*"   "3.6e+30*"    101
 "2015/10/30"   "19:00:04"       "NA"         "NA"          235
 "2015/10/31"   "01:48:04"   …   6.8e14       6.7e29        316
 "2015/10/31"   "03:36:04"       1.4e16       2.2e30        313
 "2015/10/31"   "08:48:04"       "NA"         "NA"           25
 "2015/10/31"   "09:12:09"       "NA"         "NA"          108
 "2015/10/31"   "17:36:05"       "NA"         "NA"           94
 "2015/10/31"   "18:36:04"   …   "NA"         "NA"           19
 "2015/10/31"   "19:36:04"       2.2e14       3.5e28        138
 "2015/10/31"   "23:12:09"       "NA"         "NA"           81
```

Creamos y salvamos, a partir de este arreglo, el data frame df_cme, para lo cual tenemos que entrar al sistema de dataFrame

In [8]:
```
writedlm("lasco_petit.txt", B)
```

In [6]:
```
using DataFrames, DataArrays
df = readtable("lasco_petit.txt", separator = '\t')
```

Out[6]:

	Date	Time	Central	Width	Linear	x2nd	order	speed	Accel	Mass	Kinetic	MPA
1	1996/01/11	00:14:36	267	18	499	571	426	0	-64.3*	NA	NA	272
2	1996/01/13	22:08:30	265	16	290	278	303	372	2.8*	NA	NA	266
3	1996/01/15	07:01:10	262	43	525	600	454	0	-31.1	NA	NA	272
4	1996/01/22	03:11:01	105	37	267	401	130	0	-126.3*	7.1e+13*	2.5e+28*	103
5	1996/01/26	09:16:19	90	27	262	254	271	322	1.9*	3e14	1e29	90
6	1996/01/31	06:52:13	274	47	158	219	99	0	-12.3*	2.5e+14*	3.2e+28*	272
7	1996/02/03	00:07:03	83	52	306	294	317	309	0.9*	19e14	89e28	80
8	1996/02/08	05:17:49	263	70	184	247	126	0	-6.0*	16e13	27e27	249
9	1996/02/12	05:47:26	91	53	160	100	211	236	2.0*	13e14	16e28	92
10	1996/02/17	02:06:31	279	73	317	257	378	532	9.9*	3.3e+14*	1.6e+29*	274
11	1996/02/17	05:18:59	86	36	171	64	279	819	27.9*	2.1e+14*	3.1e+28*	88
12	1996/02/19	05:15:48	98	30	266	129	403	946	36.7*	1.3e+14*	4.6e+28*	94
13	1996/03/02	04:11:53	88	36	108	95	120	177	1.0*	15e13	87e26	86
14	1996/03/03	04:12:30	99	26	186	141	232	215	2.3*	1.6e+14*	2.8e+28*	99
15	1996/03/06	05:38:36	268	55	175	NA	NA	NA	NA	3.6e+13*	5.6e+27*	261
16	1996/03/07	01:00:19	57	39	200	235	169	135	-2.3*	3.8e+14*	7.5e+28*	53
17	1996/03/07	07:51:56	91	43	60	60	61	75	0.1*	NA	NA	87
18	1996/03/08	07:12:03	90	19	170	108	229	189	2.8*	NA	NA	85
19	1996/03/09	04:27:49	84	39	93	102	82	0	-1.1*	NA	NA	82
20	1996/03/11	18:22:39	86	52	244	124	352	656	20.1*	4.4e+14*	1.3e+29*	77
21	1996/03/13	02:42:06	105	17	130	68	195	312	4.0*	NA	NA	106
22	1996/03/14	09:38:00	101	22	74	55	94	177	1.2*	NA	NA	99
23	1996/03/14	11:44:18	285	59	418	526	307	302	-8.9*	1.2e+15*	1.0e+30*	292
24	1996/03/15	13:54:27	101	26	222	200	244	386	4.7*	NA	NA	101
25	1996/03/15	23:57:34	76	29	71	46	98	198	1.9*	NA	NA	78
26	1996/03/16	02:03:38	262	27	65	26	107	292	3.8*	NA	NA	267
27	1996/03/18	02:45:52	94	22	NA	NA	NA	NA	NA	NA	NA	92
28	1996/03/18	08:33:09	276	25	158	137	177	212	1.2*	1.3e+14*	1.7e+28*	280
29	1996/03/18	16:26:43	257	32	NA	NA	NA	NA	NA	NA	NA	263
30	1996/03/22	00:48:44	282	17	142	107	177	228	2.0*	NA	NA	284
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

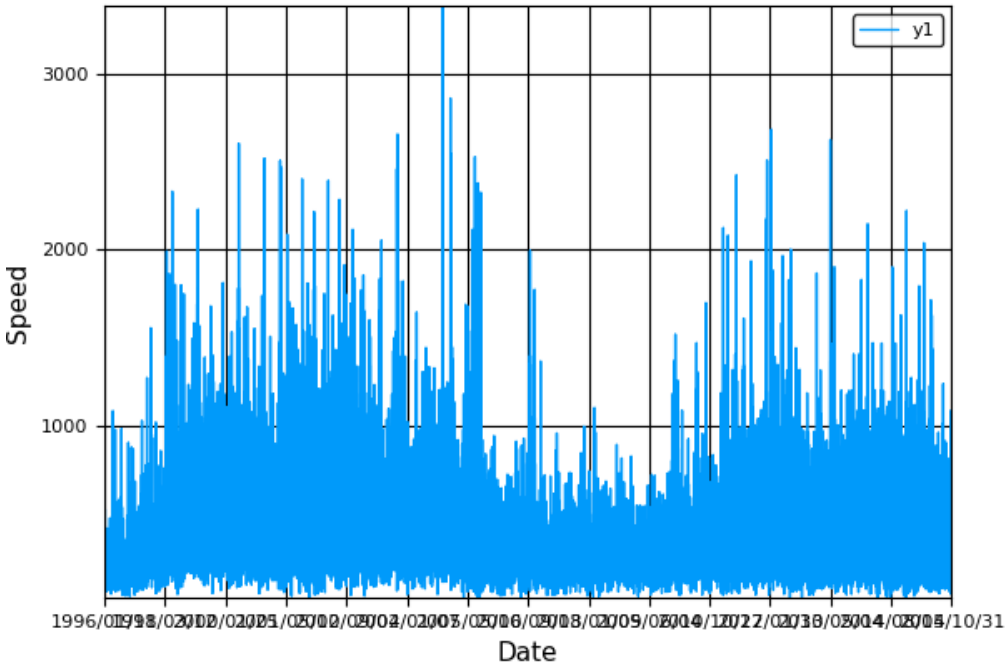
Rapidez de los CMEs a lo largo del período 1996 - 2015

Debido a que en el catálogo existen valores "NA", se usa el comando dropna() para eliminarlos.

In [7]:
```
using Plots
pyplot()
#plot(dropna(df[5]))
plot(df[1], dropna(df[5]), xlabel = "Date", ylabel = "Speed", fmt = :png)
```

```
[Plots.jl] Initializing backend: pyplot
```

Out[7]:




```
sys:1: MatplotlibDeprecationWarning: The set_axis_bgcolor function was deprecated
in version 2.0. Use set_facecolor instead.
```

Número de CMEs por año

In [38]:
```
df[206,1]
```

Out[38]:
```
"1996/12/31"
```

In [8]:
```
# ultimo indice del año
indiceY = [1995 0; 1996 206; 1997 591; 1998 1307; 1999 2323; 2000 3987; 2001 5486; 20
2007 13155; 2008 14018; 2009 14764; 2010 15881; 2011 17860; 2012 20038; 2013 22376; 2
```

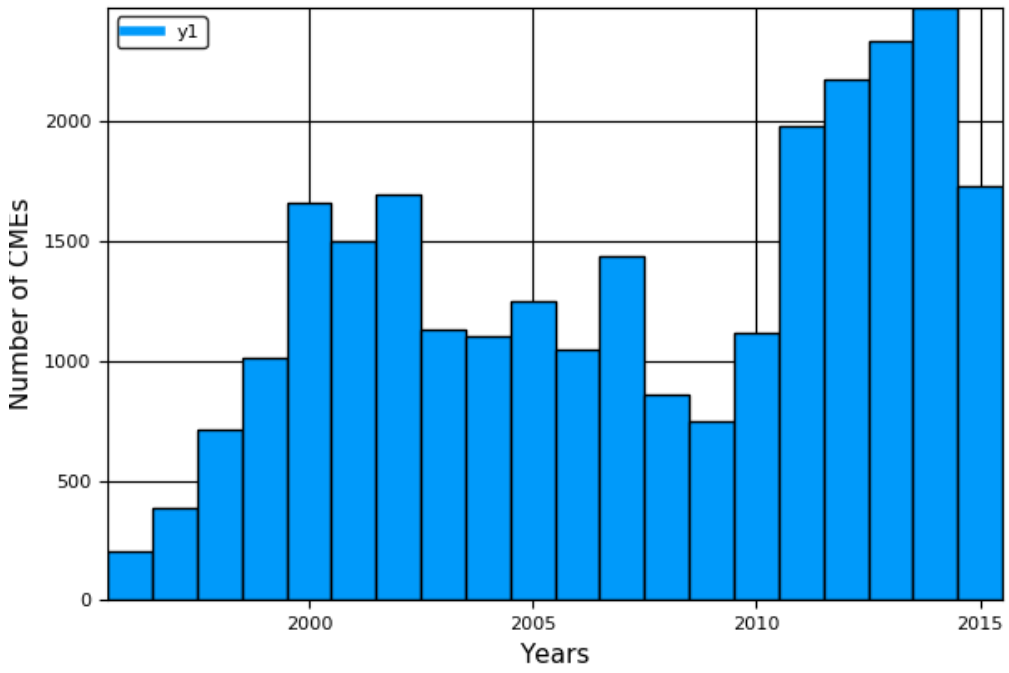
Out[8]:
```
21x2 Array{Int64,2}:
 1995      0
 1996    206
 1997    591
 1998   1307
 1999   2323
 2000   3987
 2001   5486
 2002   7186
 2003   8316
 2004   9418
 2005  10667
 2006  11713
 2007  13155
 2008  14018
 2009  14764
 2010  15881
 2011  17860
 2012  20038
 2013  22376
 2014  24854
 2015  26582
```

In [9]:
```
numero = indiceY[2:end,2] - indiceY[1:end-1,2]
```

Out[9]:
```
20-element Array{Int64,1}:
  206
  385
  716
 1016
 1664
 1499
 1700
 1130
 1102
 1249
 1046
 1442
  863
  746
 1117
 1979
 2178
 2338
 2478
 1728
```

In [10]:
```
bar(indiceY[2:end,1], numero, xlabel="Years", ylabel = "Number of CMEs", fmt = :png)
```

Out[10]:



Veamos ahora el comportamiento del ciclo solar para estos años, para lo cual utilizaremos el número de manchas solares (fuente: "Source: WDC-SILSO, Royal Observatory of Belgium, Brussels").

In [11]:
```
manchas = readdlm("SN_y_tot_V2.0.txt")
```

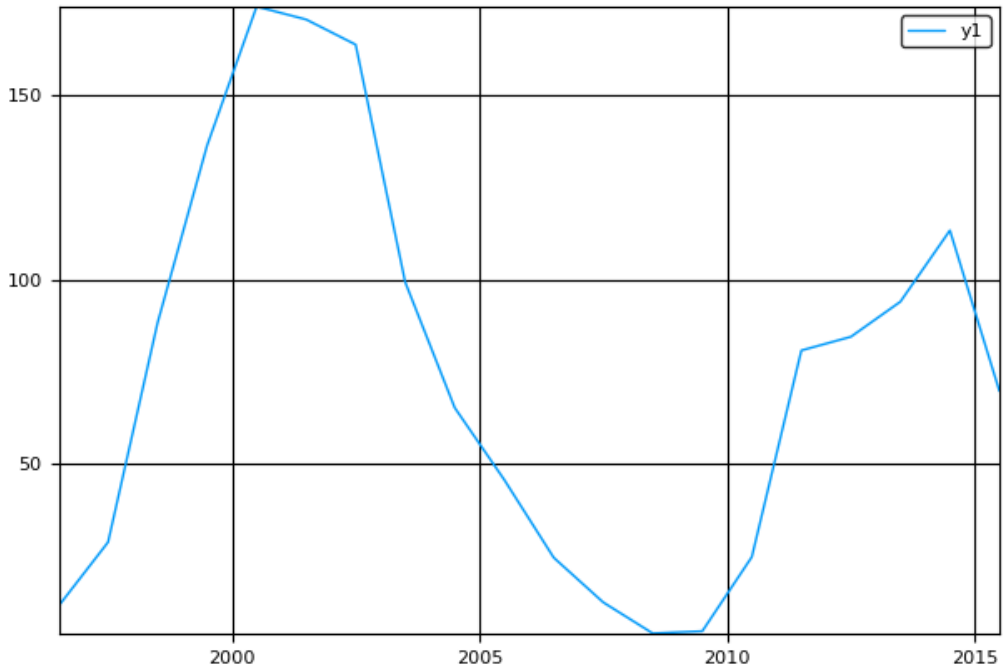
Out[11]:
```
317x5 Array{Any,2}:
 1700.5    8.3  -1.0    -1  ""
 1701.5   18.3  -1.0    -1  ""
 1702.5   26.7  -1.0    -1  ""
 1703.5   38.3  -1.0    -1  ""
 1704.5   60.0  -1.0    -1  ""
 1705.5   96.7  -1.0    -1  ""
 1706.5   48.3  -1.0    -1  ""
 1707.5   33.3  -1.0    -1  ""
 1708.5   16.7  -1.0    -1  ""
 1709.5   13.3  -1.0    -1  ""
 1710.5    5.0  -1.0    -1  ""
 1711.5    0.0  -1.0    -1  ""
 1712.5    0.0  -1.0    -1  ""
    ⋮
 2005.5   45.8   4.7  7084  ""
 2006.5   24.7   3.5  6370  ""
 2007.5   12.6   2.7  6841  ""
 2008.5    4.2   2.5  6644  ""
 2009.5    4.8   2.5  6465  ""
 2010.5   24.9   3.4  6328  ""
 2011.5   80.8   6.7  6077  ""
 2012.5   84.5   6.7  5753  ""
 2013.5   94.0   6.9  5347  ""
 2014.5  113.3   8.0  5273  ""
 2015.5   69.8   6.4  8903  ""
 2016.5   39.9   3.9  9724  "*"
```

In [12]:
```
n0 = manchas[end-20:end-1,1:2]
```

Out[12]:
```
20x2 Array{Any,2}:
 1996.5   11.6
 1997.5   28.9
 1998.5   88.3
 1999.5  136.3
 2000.5  173.9
 2001.5  170.4
 2002.5  163.6
 2003.5   99.3
 2004.5   65.3
 2005.5   45.8
 2006.5   24.7
 2007.5   12.6
 2008.5    4.2
 2009.5    4.8
 2010.5   24.9
 2011.5   80.8
 2012.5   84.5
 2013.5   94.0
 2014.5  113.3
 2015.5   69.8
```

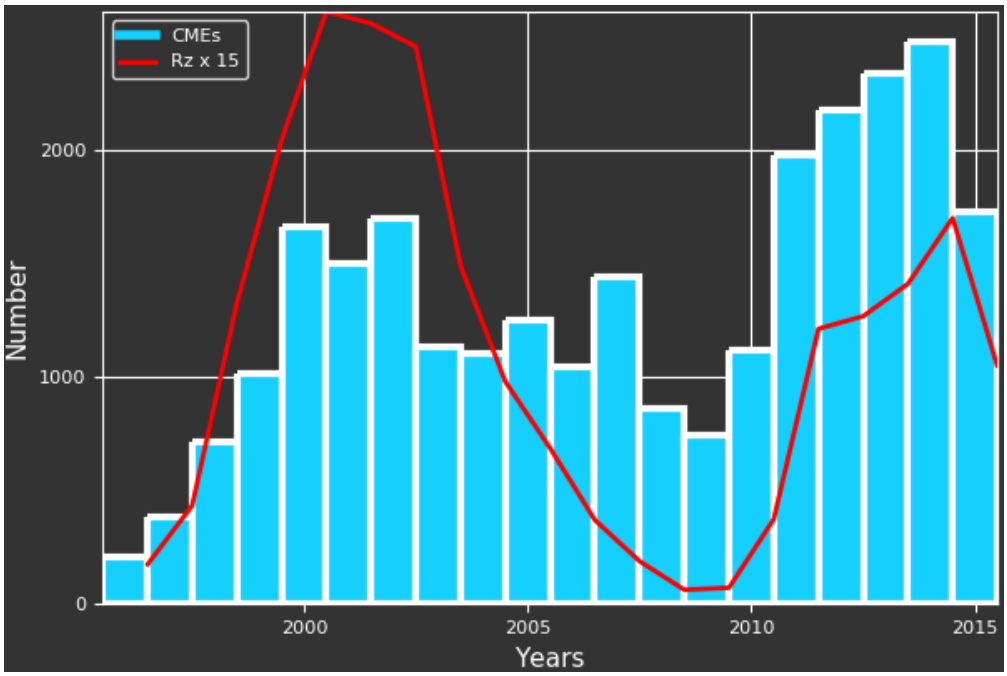
In [13]:
```
plot(n0[:,1],n0[:,2])
```

Out[13]:



In [14]:
```
pyplot()
bar(indiceY[2:end,1], numero, xlabel="Years", ylabel = "Number",
lab="CMEs",w=3, background_color=RGB(0.2,0.2,0.2))
plot!(n0[:,1],15*n0[:,2], lab = "Rz x 15", line = :red, linewidth = 2, fmt = :png)
```

Out[14]:

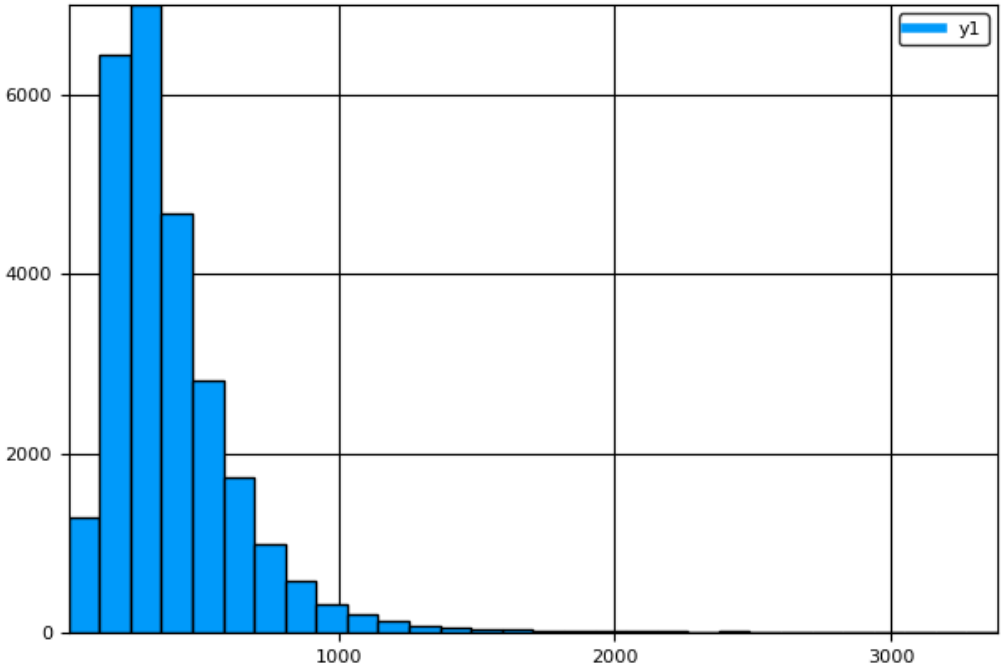


Distribución de rapideces de las CMEs

Se puede obtener fácilmente mediante el cálculo del histograma

In [15]:
```
h = histogram(dropna(df[5]))
```

Out[15]:



In [290]:
```
v = hist(dropna(df[5]), 24)
```

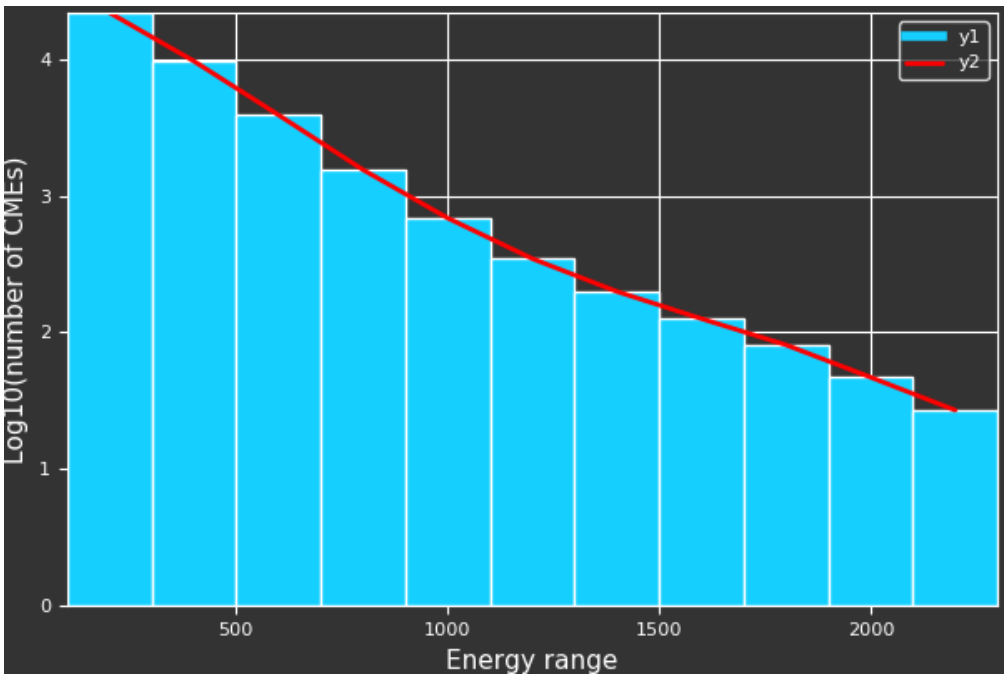
Out[290]:
```
(0.0:200.0:3400.0,[4721,12148,5724,2338,858,339,147,73,45,34,20,10,11,4,1,0,1])
```

In [29]:
```
# Programa para buscar valores por arriva de diferentes rapideces
speed = dropna(df[5])
nk2200 = 0; nk2000 = 0; nk1800 = 0; nk1600 = 0; nk1400 = 0; nk1200 = 0; nk1000 = 0;
nk0800 = 0; nk0600 = 0; nk0400 = 0; nk0200 = 0
for i = 1:26474
    if speed[i] > 200
        nk0200 += 1
    end
    if speed[i] > 400
        nk0400 += 1
    end
    if speed[i] > 600
        nk0600 += 1
    end
    if speed[i] > 800
        nk0800 += 1
    end
    if speed[i] > 1000
        nk1000 += 1
    end
    if speed[i] > 1200
        nk1200 += 1
    end
    if speed[i] > 1400
        nk1400 += 1
    end
    if speed[i] > 1600
        nk1600 += 1
    end
    if speed[i] > 1800
        nk1800 += 1
    end
    if speed[i] > 2000
        nk2000 += 1
    end
    if speed[i] > 2200
        nk2200 += 1
    end
end
nk = [nk0200 nk0400 nk0600 nk0800 nk1000 nk1200 nk1400 nk1600 nk1800 nk2000 nk2200]
```

Out[29]:
```
1x11 Array{Int64,2}:
 21753  9605  3881  1543  685  346  199  126  81  47  27
```

In [17]:
```
range = collect(200:200:2200)
bar(range, log10(nk)',
xlabel="Energy range", ylabel="Log10(number of CMEs)",
background_color=RGB(0.2,0.2,0.2))
plot!(range, log10(nk)', line = :red, linewidth = 2, fmt = :png)
```

Out[17]:



Los CMEs con categoría de Halo

Debido a sus características de "verse" a ambos lados del sol, estas CMEs tienen rumbo hacia la Tierra, por lo que son de mayor interés para el clima espacial. Como sólo estamos interesados en los CMEs tipo Halo, es necesario hacer un nuevo archivo que contenga tales eventos.

In [18]:
```
df1 = df[(df[:Central] .== "Halo"), :]
```

Out[18]:

	Date	Time	Central	Width	Linear	x2nd	order	speed	Accel	Mass	Kinetic	MPA
1	1996/04/29	14:38:48	Halo	360	65	NA	NA	NA	NA	NA	NA	149
2	1996/08/16	14:14:06	Halo	360	364	336	390	399	2.0*	5.6e+14*	3.7e+29*	158
3	1996/11/07	23:20:05	Halo	360	497	366	630	586	8.7	4.2e+15*	5.2e+30*	114
4	1996/12/02	15:35:05	Halo	360	538	641	430	478	-8.8	1.6e+15*	2.3e+30*	253
5	1997/01/06	15:10:42	Halo	360	136	51	224	319	4.1	5.8e+14*	5.4e+28*	180
6	1997/02/07	00:30:05	Halo	360	490	270	718	635	14.3	4.1e+15*	4.9e+30*	266
7	1997/04/07	14:27:44	Halo	360	878	850	905	896	3.3	1.0e+16*	4.0e+31*	123
8	1997/04/27	10:26:05	Halo	360	280	288	271	268	-.5	4.5e+14*	1.7e+29*	268
9	1997/04/27	14:59:05	Halo	360	255	324	180	0	-4.9	2.5e+14*	8.1e+28*	270
10	1997/05/12	05:30:05	Halo	360	464	580	335	220	-15.0*	4.2e+15*	4.5e+30*	264
11	1997/07/30	04:45:47	Halo	360	104	90	119	162	.8	8.2e+14*	4.5e+28*	269
12	1997/08/30	01:30:35	Halo	360	371	291	460	551	9.3	1.7e+15*	1.2e+30*	67
13	1997/09/17	20:28:48	Halo	360	377	377	377	377	0	2.6e+15*	1.9e+30*	263
14	1997/09/28	01:08:33	Halo	360	359	317	404	409	2.8	4.0e+15*	2.6e+30*	87
15	1997/10/21	18:03:45	Halo	360	523	552	491	484	-2.9	9.5e+14*	1.3e+30*	90
16	1997/10/23	11:26:50	Halo	360	503	443	573	526	3.7	8.2e+15*	1.0e+31*	305
17	1997/11/04	06:10:05	Halo	360	785	1009	548	698	-22.1	7.5e+15*	2.3e+31*	243
18	1997/11/06	12:10:41	Halo	360	1556	1755	1346	1473	-44.1	5.5e+15*	6.6e+31*	262
19	1997/11/17	08:27:05	Halo	360	611	743	470	532	-14.5	8.2e+15*	1.5e+31*	164
20	1997/11/19	12:27:08	Halo	360	150	166	133	0	-5.1*	8.1e+14*	9.1e+28*	280
21	1997/12/18	23:47:31	Halo	360	417	363	472	436	2.9	8.3e+15*	7.2e+30*	102
22	1998/01/02	23:28:20	Halo	360	438	337	548	515	6.5	5.5e+15*	5.3e+30*	275
23	1998/01/17	04:09:20	Halo	360	350	242	471	429	5.6	1.6e+15*	9.7e+29*	82
24	1998/01/21	06:37:25	Halo	360	361	335	389	384	1.5*	2.6e+15*	1.7e+30*	179
25	1998/01/25	15:26:34	Halo	360	693	773	611	657	-7.4	1.1e+16*	2.7e+31*	112
26	1998/02/27	20:07:21	Halo	360	422	506	340	0	-10.8*	NA	NA	83
27	1998/03/29	03:48:28	Halo	360	1397	1416	1378	1389	-4.9*	1.7e+16*	1.7e+32*	189
28	1998/03/31	06:12:02	Halo	360	1992	NA	NA	NA	NA	1.6e+16*	3.1e+32*	177
29	1998/04/23	05:55:22	Halo	360	1691	1919	1466	1649	-44.4*	5.5e+15*	7.9e+31*	116
30	1998/04/27	08:56:06	Halo	360	1385	1035	1743	1696	74.4	2.2e+16*	2.1e+32*	79
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

In [105]:
```
length(df1[:Date])
```

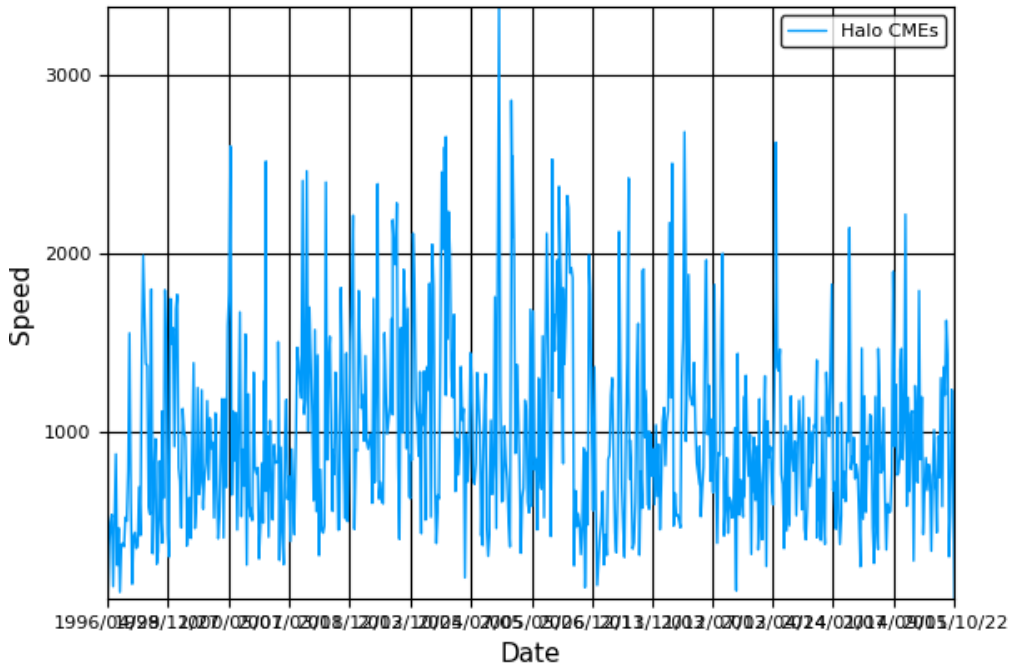
Out[105]: 693

Es decir que del total de 26583 CMEs en el periodo solamente 693 son de tipo "Halo". O sea que la probabilidad de tener un evento Halo es de 693/26583 = 0.02607, ó aproximadamente 2.67 %

Rapidez de CMEs tipo Halo a lo largo del periodo

In [19]:
```
plot(df1[1], dropna(df1[5]),
xlabel = "Date", ylabel = "Speed", lab = "Halo CMEs", fmt = :png)
```

Out[19]:



Número de CMEs tipo Halo a lo largo del periodo

In [70]:
```
df1[410,1]
```

Out[70]: "2011/02/01"

In [71]:
```
# Ultimo índice del año
indiceY1 = [1995 0; 1996 4; 1997 21; 1998 50; 1999 77; 2000 135; 2001 198;
    2002 250; 2003 280; 2004 320; 2005 379; 2006 393; 2007 396; 2008 397;
    2009 398; 2010 409; 2011 450; 2012 534; 2013 589; 2014 658; 2015 693]
```

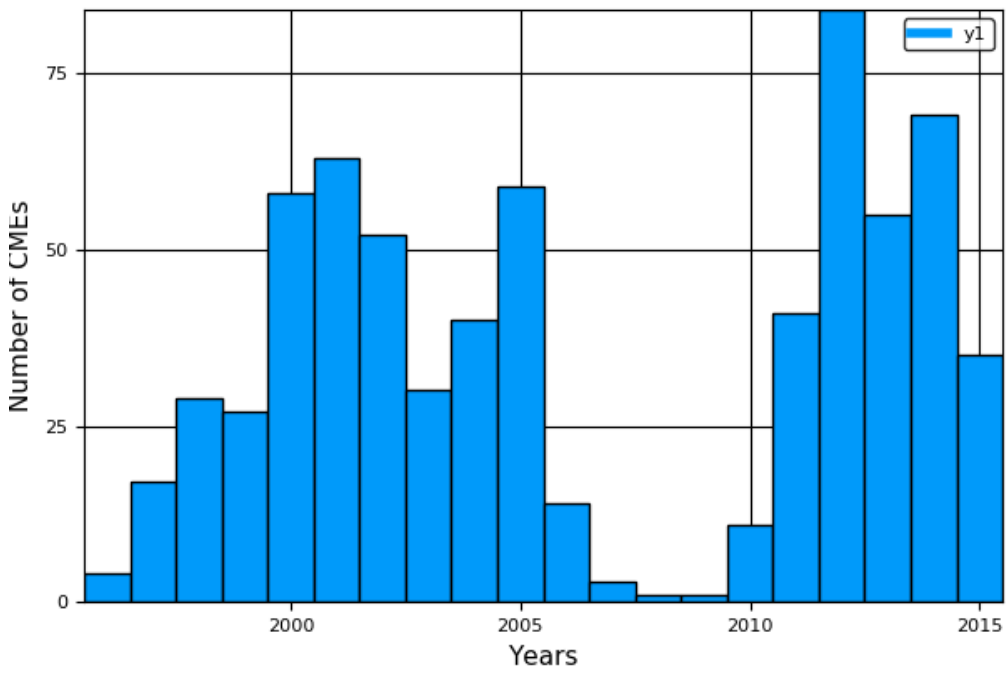
Out[71]:
```
21x2 Array{Int64,2}:
 1995    0
 1996    4
 1997   21
 1998   50
 1999   77
 2000  135
 2001  198
 2002  250
 2003  280
 2004  320
 2005  379
 2006  393
 2007  396
 2008  397
 2009  398
 2010  409
 2011  450
 2012  534
 2013  589
 2014  658
 2015  693
```

In [72]:
```
numero1 = indiceY1[2:end,2] - indiceY1[1:end-1,2]
```

Out[72]:
```
20-element Array{Int64,1}:
  4
 17
 29
 27
 58
 63
 52
 30
 40
 59
 14
  3
  1
  1
 11
 41
 84
 55
 69
 35
```

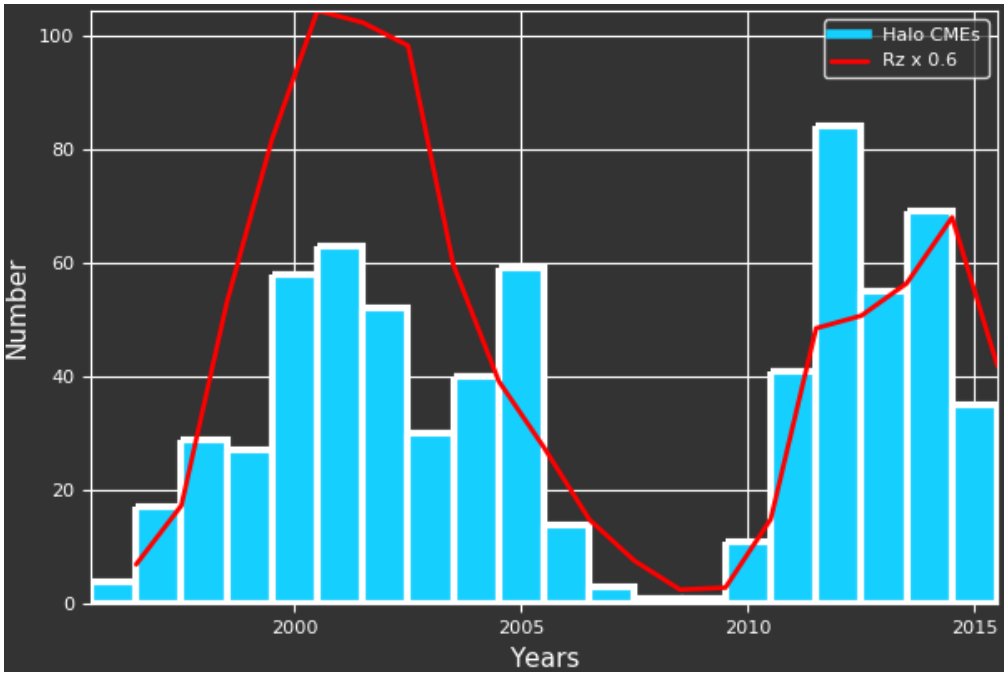
In [73]:
```
bar(indiceY1[2:end,1], numero1, xlabel="Years", ylabel = "Number of CMEs", fmt = :pn
```

Out[73]:



In [74]:
```
pyplot()
bar(indiceY1[2:end,1], numero1, xlabel="Years", ylabel = "Number",
lab="Halo CMEs",w=3, background_color=RGB(0.2,0.2,0.2))
plot!(n0[:,1],0.6*n0[:,2], lab = "Rz x 0.6", line = :red, linewidth = 2, fmt = :png)
```

Out[74]:

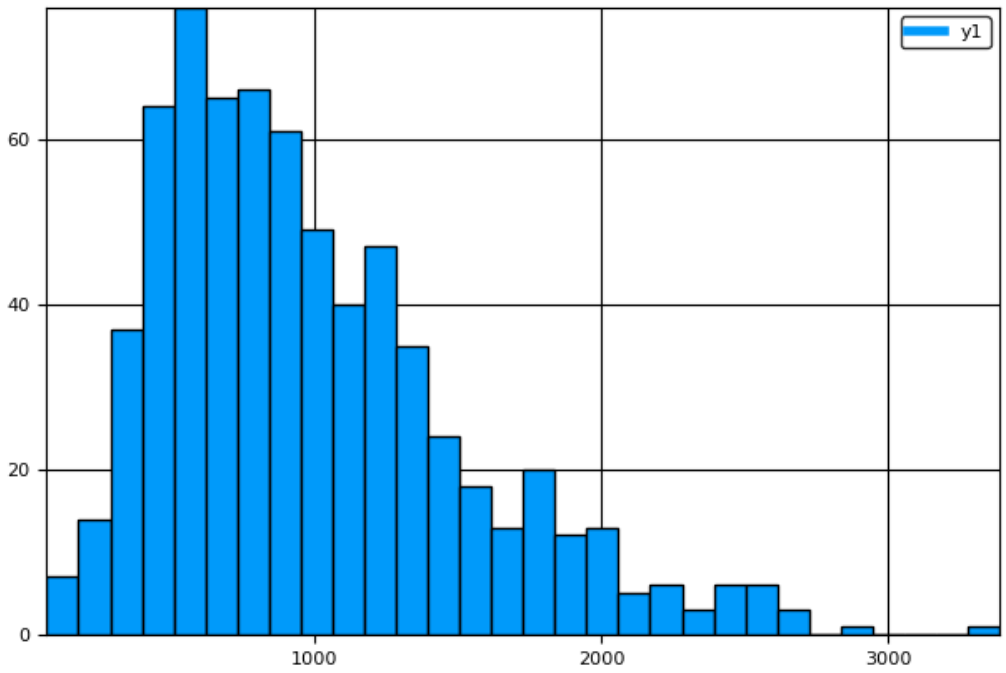


Distribución de rapideces de las Halo CMEs

Se puede obtener fácilmente mediante el cálculo del histograma

In [75]:
```
h1 = histogram(dropna(df1[5]))
```

Out[75]:



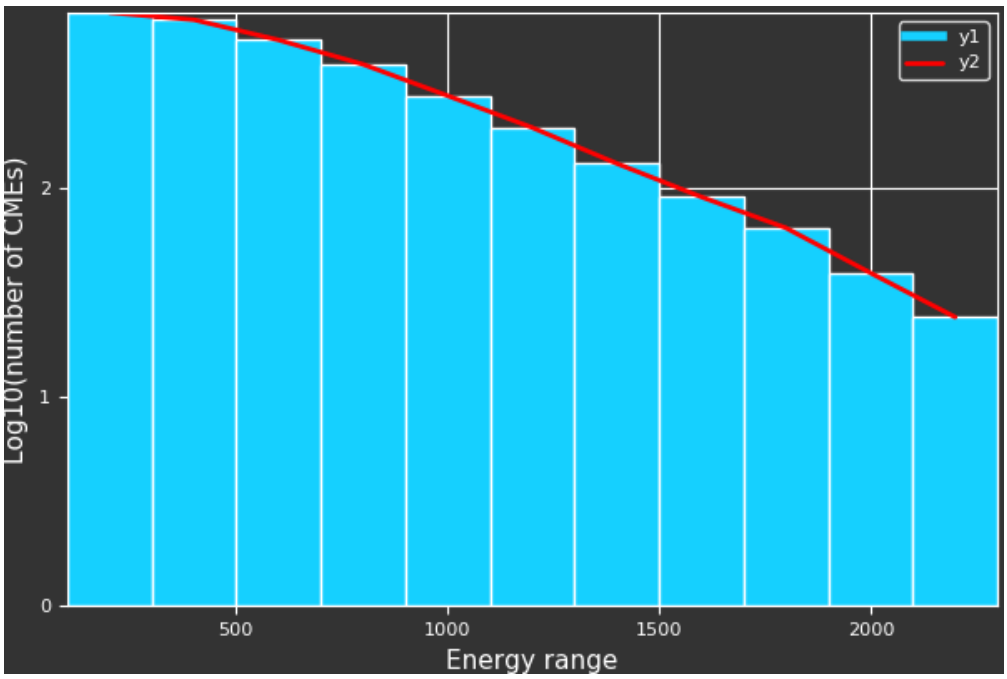
In [76]:
```
# Programa para buscar valores por arriva de diferentes rapideces
speed1 = dropna(df1[5])
nk2200a = 0; nk2000a = 0; nk1800a = 0; nk1600a = 0; nk1400a = 0;
nk1200a = 0; nk1000a = 0; nk0800a = 0; nk0600a = 0; nk0400a = 0;
nk0200a = 0
for i = 1:692
    if speed1[i] > 200
        nk0200a += 1
    end
    if speed1[i] > 400
        nk0400a += 1
    end
    if speed1[i] > 600
        nk0600a += 1
    end
    if speed1[i] > 800
        nk0800a += 1
    end
    if speed1[i] > 1000
        nk1000a += 1
    end
    if speed1[i] > 1200
        nk1200a += 1
    end
    if speed1[i] > 1400
        nk1400a += 1
    end
    if speed1[i] > 1600
        nk1600a += 1
    end
    if speed1[i] > 1800
        nk1800a += 1
    end
    if speed1[i] > 2000
        nk2000a += 1
    end
    if speed1[i] > 2200
        nk2200a += 1
    end
end
#nk1 = [nk0200a nk0400a nk0600a nk0800a nk1000a nk1200a nk1400a nk1600a
#    nk1800a nk2000a nk2200a]
```

In [77]:
```
nk1 = [nk0200a; nk0400a; nk0600a; nk0800a; nk1000a; nk1200a; nk1400a;
    nk1600a; nk1800a; nk2000a; nk2200a]
```

Out[77]:
```
11-element Array{Int64,1}:
 684
 632
 506
 387
 274
 193
 130
  90
  64
  39
  24
```

In [78]:
```
range = collect(200:200:2200)
bar(range, log10(nk1),
xlabel="Energy range", ylabel="Log10(number of CMEs)",
background_color=RGB(0.2,0.2,0.2))
plot!(range, log10(nk1), line = :red, linewidth = 2, fmt = :png)
```

Out[78]:

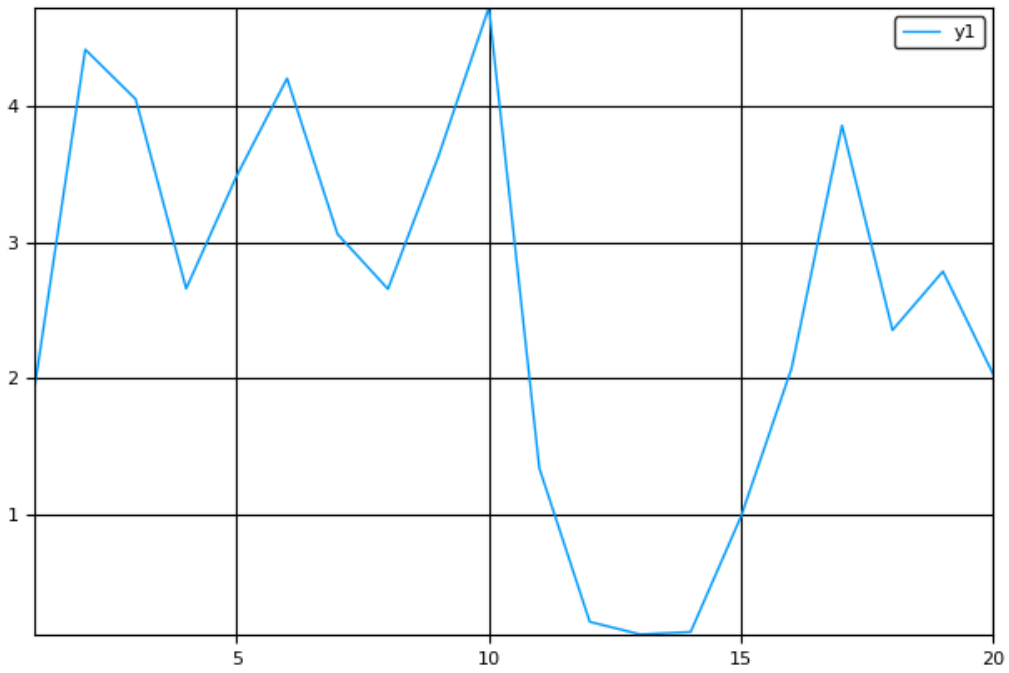


In [80]:
```
dfes = [numero numero1 100*(numero1./numero)]
```

Out[80]:
```
20x3 Array{Float64,2}:
  206.0    4.0  1.94175
  385.0   17.0  4.41558
  716.0   29.0  4.05028
 1016.0   27.0  2.65748
 1664.0   58.0  3.48558
 1499.0   63.0  4.2028
 1700.0   52.0  3.05882
 1130.0   30.0  2.65487
 1102.0   40.0  3.62976
 1249.0   59.0  4.72378
 1046.0   14.0  1.33843
 1442.0    3.0  0.208044
  863.0    1.0  0.115875
  746.0    1.0  0.134048
 1117.0   11.0  0.984781
 1979.0   41.0  2.07175
 2178.0   84.0  3.85675
 2338.0   55.0  2.35244
 2478.0   69.0  2.7845
 1728.0   35.0  2.02546
```

In [82]:
```
plot(dfes[:,3])
```

Out[82]:



Referencias

S. Yashiro, G. Michalek, and N. Gopalswamy, A comparison of coronal mass ejections identified by manual and automatic methods, accepted for the publication in Annales Geophysicae

N. Gopalswamy, S. Yashiro, G. Michalek, G. Stenborg, A. Vourlidas, S. Freeland, and R. Howard, The SOHO/LASCO CME Catalog, accepted for the publication in Earth, Moon, and Planets

Gopalswamy, N., A. Lara, S. Yashiro, S. Nunes, and R. A. Howard, Coronal Mass Ejection Activity During Solar Cycle 23, In Solar variability as an input to the Earth's environment. Ed.: A. Wilson. ESA SP-535, Noordwijk: ESA Publications Division, p. 403, 2003

Gopalswamy, N., Nunes, S., Yashiro, S. and Howard, R. A., Variability of Solar Eruptions during cycle 23, Adv. Space Res., 34(2), 391, 2004.

Gopalswamy, N., A global picture of CMEs in the inner heliosphere, in The Sun and the Heliosphere as an Integrated System, edited by G. Poletto and S. T. Suess, Kluwer, Boston, Chapter 8, p. 201, 2004

St. Cyr, O. C. et al., Properties of coronal mass ejections: SOHO LASCO observations from January 1996 to June 1998, J. Geophys. Res., 105, 18169, 2000.

Vourlidas, A., Buzasi, D., Howard, R. A., and Esfandiari, E., Mass and energy properties of LASCO CMEs, Solar variability: from core to outer frontiers, Ed. A. Wilson. ESA SP-506, Vol. 1. Noordwijk: ESA Publications Division, p. 91, 2002

Yashiro, S., N. Gopalswamy, G. Michalek, O. C. St.Cyr, S. P. Plunkett, N. B. Rich, and R. A. Howard, A catalog of white light coronal mass ejections observed by the SOHO spacecraft, Journal of Geophysical Research, 109, A07105, doi:10.1029/2003JA010282, 2004.