Rules for integrands of the form $u\,(a+b\,\text{ArcTan}[c+d\,x])^p$

1. $\int u\,(a+b\,\text{ArcTan}[c+d\,x])^p\,dx$

1: $\int (a+b\,\text{ArcTan}[c+d\,x])^p\,dx$ when $p\in\mathbb{Z}^+$

Derivation: Integration by substitution

Rule: If $p\in\mathbb{Z}^+$, then

$$\int (a+b\,\text{ArcTan}[c+d\,x])^p\,dx \to \frac{1}{d}\,\text{Subst}\left[\int (a+b\,\text{ArcTan}[x])^p\,dx,\ x,\ c+d\,x\right]$$

Program code:

```
Int[(a_.+b_.*ArcTan[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[(a+b*ArcTan[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d},x] && IGtQ[p,0]
```

```
Int[(a_.+b_.*ArcCot[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[(a+b*ArcCot[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d},x] && IGtQ[p,0]
```

U: $\int (a+b\,\text{ArcTan}[c+d\,x])^p\,dx$ when $p\notin\mathbb{Z}^+$

Rule: If $p\notin\mathbb{Z}^+$, then

$$\int (a+b\,\text{ArcTan}[c+d\,x])^p\,dx \to \int (a+b\,\text{ArcTan}[c+d\,x])^p\,dx$$

Program code:

```
Int[(a_.+b_.*ArcTan[c_+d_.*x_])^p_,x_Symbol] :=
  Unintegrable[(a+b*ArcTan[c+d*x])^p,x] /;
FreeQ[{a,b,c,d,p},x] && Not[IGtQ[p,0]]
```

```
Int[(a_.+b_.*ArcCot[c_+d_.*x_])^p_,x_Symbol] :=
  Unintegrable[(a+b*ArcCot[c+d*x])^p,x] /;
FreeQ[{a,b,c,d,p},x] && Not[IGtQ[p,0]]
```

2. $\int (e+f x)^m (a+b \operatorname{ArcTan}[c+d x])^p \, dx$

1: $\int (e+f x)^m (a+b \operatorname{ArcTan}[c+d x])^p \, dx$ when $d e-c f == 0 \land p \in \mathbb{Z}^+$

Derivation: Integration by substitution

Rule: If $d e-c f == 0 \land p \in \mathbb{Z}^+$, then

$$\int (e+f x)^m (a+b \operatorname{ArcTan}[c+d x])^p \, dx \rightarrow \frac{1}{d} \operatorname{Subst}\left[\int \left(\frac{f x}{d}\right)^m (a+b \operatorname{ArcTan}[x])^p \, dx,\ x,\ c+d x\right]$$

Program code:

```
Int[(e_.+f_.*x_)^m_.*(a_.+b_.*ArcTan[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[(f*x/d)^m*(a+b*ArcTan[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,e,f,m},x] && EqQ[d*e-c*f,0] && IGtQ[p,0]
```

```
Int[(e_.+f_.*x_)^m_.*(a_.+b_.*ArcCot[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[(f*x/d)^m*(a+b*ArcCot[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,e,f,m},x] && EqQ[d*e-c*f,0] && IGtQ[p,0]
```

2: $\int (e+f x)^m (a+b \operatorname{ArcTan}[c+d x])^p \, dx$ when $p \in \mathbb{Z}^+ \land m+1 \in \mathbb{Z}^-$

Derivation: Integration by parts

Basis: $\partial_x (a+b \operatorname{ArcTan}[c+d x])^p == \frac{b d p (a+b \operatorname{ArcTan}[c+d x])^{p-1}}{1+(c+d x)^2}$

Rule: If $p \in \mathbb{Z}^+ \land m+1 \in \mathbb{Z}^-$, then

$$\int (e+f x)^m (a+b \operatorname{ArcTan}[c+d x])^p \, dx \longrightarrow \frac{(e+f x)^{m+1} (a+b \operatorname{ArcTan}[c+d x])^p}{f (m+1)} - \frac{b d p}{f (m+1)} \int \frac{(e+f x)^{m+1} (a+b \operatorname{ArcTan}[c+d x])^{p-1}}{1+(c+d x)^2} \, dx$$

Program code:

```
Int[(e_.+f_.*x_)^m_*(a_.+b_.*ArcTan[c_+d_.*x_])^p_.,x_Symbol] :=
  (e+f*x)^(m+1)*(a+b*ArcTan[c+d*x])^p/(f*(m+1)) -
  b*d*p/(f*(m+1))*Int[(e+f*x)^(m+1)*(a+b*ArcTan[c+d*x])^(p-1)/(1+(c+d*x)^2),x] /;
FreeQ[{a,b,c,d,e,f},x] && IGtQ[p,0] && ILtQ[m,-1]
```

```
Int[(e_.+f_.*x_)^m_*(a_.+b_.*ArcCot[c_+d_.*x_])^p_.,x_Symbol] :=
  (e+f*x)^(m+1)*(a+b*ArcCot[c+d*x])^p/(f*(m+1)) +
  b*d*p/(f*(m+1))*Int[(e+f*x)^(m+1)*(a+b*ArcCot[c+d*x])^(p-1)/(1+(c+d*x)^2),x] /;
FreeQ[{a,b,c,d,e,f},x] && IGtQ[p,0] && ILtQ[m,-1]
```

3: $\int (e+f x)^m (a+b \operatorname{ArcTan}[c+d x])^p \, dx$ when $p \in \mathbb{Z}^+$

Derivation: Integration by substitution

Rule: If $p \in \mathbb{Z}^+$, then

$$\int (e+f x)^m (a+b \operatorname{ArcTan}[c+d x])^p \, dx \longrightarrow \frac{1}{d} \operatorname{Subst}\left[\int \left(\frac{d e-c f}{d}+\frac{f x}{d}\right)^m (a+b \operatorname{ArcTan}[x])^p \, dx,\ x,\ c+d x\right]$$

Program code:

```
Int[(e_.+f_.*x_)^m_.*(a_.+b_.*ArcTan[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[((d*e-c*f)/d+f*x/d)^m*(a+b*ArcTan[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,e,f,m,p},x] && IGtQ[p,0]
```

```
Int[(e_.+f_.*x_)^m_.*(a_.+b_.*ArcCot[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[((d*e-c*f)/d+f*x/d)^m*(a+b*ArcCot[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,e,f,m,p},x] && IGtQ[p,0]
```

U: $\int (e + f x)^m (a + b \text{ArcTan}[c + d x])^p \, dx$ when $p \notin \mathbb{Z}^+$

Rule: If $p \notin \mathbb{Z}^+$, then

$$\int (e + f x)^m (a + b \text{ArcTan}[c + d x])^p \, dx \rightarrow \int (e + f x)^m (a + b \text{ArcTan}[c + d x])^p \, dx$$

Program code:

```
Int[(e_.+f_.*x_)^m_.*(a_.+b_.*ArcTan[c_+d_.*x_])^p_,x_Symbol] :=
  Unintegrable[(e+f*x)^m*(a+b*ArcTan[c+d*x])^p,x] /;
FreeQ[{a,b,c,d,e,f,m,p},x] && Not[IGtQ[p,0]]
```

```
Int[(e_.+f_.*x_)^m_.*(a_.+b_.*ArcCot[c_+d_.*x_])^p_,x_Symbol] :=
  Unintegrable[(e+f*x)^m*(a+b*ArcCot[c+d*x])^p,x] /;
FreeQ[{a,b,c,d,e,f,m,p},x] && Not[IGtQ[p,0]]
```

3. $\int (e + f x^n)^m (a + b \text{ArcTan}[c + d x])^p \, dx$

1. $\int \frac{\text{ArcTan}[a + b x]}{c + d x^n} \, dx$

1: $\int \frac{\text{ArcTan}[a + b x]}{c + d x^n} \, dx$ when $n \in \mathbb{Q}$

Derivation: Algebraic expansion

Basis: $\text{ArcTan}[z] == \frac{1}{2} i \text{Log}[1 - i z] - \frac{1}{2} i \text{Log}[1 + i z]$

Basis: $\text{ArcCot}[z] == \frac{i}{2} \text{Log}\left[1 - \frac{i}{z}\right] - \frac{i}{2} \text{Log}\left[1 + \frac{i}{z}\right]$

Rule: If $n \in \mathbb{Q}$, then

$$\int \frac{\text{ArcTan}[a+b\,x]}{c+d\,x^n}\,dx \longrightarrow \frac{i}{2}\int \frac{\text{Log}[1-i\,a-i\,b\,x]}{c+d\,x^n}\,dx-\frac{i}{2}\int \frac{\text{Log}[1+i\,a+i\,b\,x]}{c+d\,x^n}\,dx$$

Program code:

```
Int[ArcTan[a_+b_.*x_]/(c_+d_.*x_^n_.),x_Symbol] :=
  I/2*Int[Log[1-I*a-I*b*x]/(c+d*x^n),x] -
  I/2*Int[Log[1+I*a+I*b*x]/(c+d*x^n),x] /;
FreeQ[{a,b,c,d},x] && RationalQ[n]
```

```
Int[ArcCot[a_+b_.*x_]/(c_+d_.*x_^n_.),x_Symbol] :=
  I/2*Int[Log[(-I+a+b*x)/(a+b*x)]/(c+d*x^n),x] -
  I/2*Int[Log[(I+a+b*x)/(a+b*x)]/(c+d*x^n),x] /;
FreeQ[{a,b,c,d},x] && RationalQ[n]
```

2: $\int \frac{\text{ArcTan}[a+b\,x]}{c+d\,x^n}\,dx$ when $n \notin \mathbb{Q}$

Rule: If $n \notin \mathbb{Q}$, then

$$\int \frac{\text{ArcTan}[a+b\,x]}{c+d\,x^n}\,dx \longrightarrow \int \frac{\text{ArcTan}[a+b\,x]}{c+d\,x^n}\,dx$$

Program code:

```
Int[ArcTan[a_+b_.*x_]/(c_+d_.*x_^n_),x_Symbol] :=
  Unintegrable[ArcTan[a+b*x]/(c+d*x^n),x] /;
FreeQ[{a,b,c,d,n},x] && Not[RationalQ[n]]
```

```
Int[ArcCot[a_+b_.*x_]/(c_+d_.*x_^n_),x_Symbol] :=
  Unintegrable[ArcCot[a+b*x]/(c+d*x^n),x] /;
FreeQ[{a,b,c,d,n},x] && Not[RationalQ[n]]
```

4: $\int \left(A + B x + C x^2\right)^q \left(a + b \operatorname{ArcTan}[c + d x]\right)^p dx$ when $B \left(1 + c^2\right) - 2 A c d == 0 \land 2 c C - B d == 0$

Derivation: Integration by substitution

Basis: If $B \left(1 + c^2\right) - 2 A c d == 0 \land 2 c C - B d == 0$, then $A + B x + C x^2 == \frac{C}{d^2} + \frac{C}{d^2} (c + d x)^2$

Rule: If $B \left(1 + c^2\right) - 2 A c d == 0 \land 2 c C - B d == 0$, then

$$\int \left(A + B x + C x^2\right)^q \left(a + b \operatorname{ArcTan}[c + d x]\right)^p dx \rightarrow \frac{1}{d} \operatorname{Subst}\left[\int \left(\frac{C}{d^2} + \frac{C x^2}{d^2}\right)^q \left(a + b \operatorname{ArcTan}[x]\right)^p dx,\ x,\ c + d x\right]$$

Program code:

```
Int[(A_.+B_.*x_+C_.*x_^2)^q_.*(a_.+b_.*ArcTan[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[(C/d^2+C/d^2*x^2)^q*(a+b*ArcTan[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,A,B,C,p,q},x] && EqQ[B*(1+c^2)-2*A*c*d,0] && EqQ[2*c*C-B*d,0]
```

```
Int[(A_.+B_.*x_+C_.*x_^2)^q_.*(a_.+b_.*ArcCot[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[(C/d^2+C/d^2*x^2)^q*(a+b*ArcCot[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,A,B,C,p,q},x] && EqQ[B*(1+c^2)-2*A*c*d,0] && EqQ[2*c*C-B*d,0]
```

5: $\int (e+f x)^m \left(A+B x+C x^2\right)^q (a+b \operatorname{ArcTan}[c+d x])^p \, dx$ when $B\left(1+c^2\right)-2 A c d=0 \land 2 c C-B d=0$

Derivation: Integration by substitution

Basis: If $B\left(1+c^2\right)-2 A c d=0 \land 2 c C-B d=0$, then $A+B x+C x^2=\frac{C}{d^2}+\frac{C}{d^2}(c+d x)^2$

Rule: If $B\left(1+c^2\right)-2 A c d=0 \land 2 c C-B d=0$, then

$$\int (e+f x)^m \left(A+B x+C x^2\right)^q (a+b \operatorname{ArcTan}[c+d x])^p \, dx \to \frac{1}{d} \operatorname{Subst}\left[\int \left(\frac{d e-c f}{d}+\frac{f x}{d}\right)^m \left(\frac{C}{d^2}+\frac{C x^2}{d^2}\right)^q (a+b \operatorname{ArcTan}[x])^p \, dx,\ x,\ c+d x\right]$$

Program code:

```
Int[(e_.+f_.*x_)^m_.*(A_.+B_.*x_+C_.*x_^2)^q_.*(a_.+b_.*ArcTan[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[((d*e-c*f)/d+f*x/d)^m*(C/d^2+C/d^2*x^2)^q*(a+b*ArcTan[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,e,f,A,B,C,m,p,q},x] && EqQ[B*(1+c^2)-2*A*c*d,0] && EqQ[2*c*C-B*d,0]
```

```
Int[(e_.+f_.*x_)^m_.*(A_.+B_.*x_+C_.*x_^2)^q_.*(a_.+b_.*ArcCot[c_+d_.*x_])^p_.,x_Symbol] :=
  1/d*Subst[Int[((d*e-c*f)/d+f*x/d)^m*(C/d^2+C/d^2*x^2)^q*(a+b*ArcCot[x])^p,x],x,c+d*x] /;
FreeQ[{a,b,c,d,e,f,A,B,C,m,p,q},x] && EqQ[B*(1+c^2)-2*A*c*d,0] && EqQ[2*c*C-B*d,0]
```